C-141 ALL WEATHER LANDING SYSTEM (AWLS) FLIGHT TEST REPORT: OPTIMIZATION AND PRE-EXPERIMENTAL PHASES

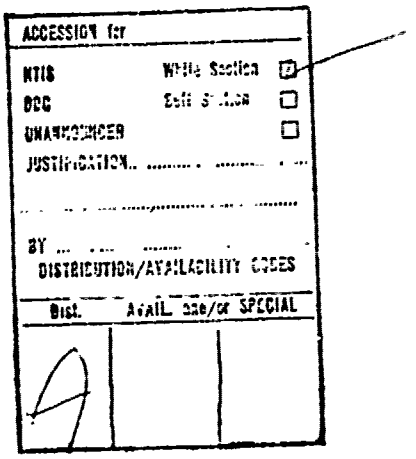
Robert J. Hovde

Air Force Flight Dynamics Laboratory

Prepared for:

Federal Aviation Administration

April 1974



NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-74-192		AD/A-003952

4. Title and Subtitle	5. Report Date
C-141 All Weather Landing System (AWLS) Flight Test Report: Optimization and Pre-Experimental Phases	April 1974
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Robert J. Hovde, Capt. USAF	AFFDL-TM-74-109-FGSA
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Air Force Flight Dynamics Laboratory Wright-Patterson AFB, Ohio 45433	11. Contract or Grant No. DOT-FA70WAI-173
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D. C. 20590	Final Report Nov. 1, 1972-Feb. 19, 1974
	14. Sponsoring Agency Code
15. Supplementary Notes	

16. Abstract

A chronological description of flight tests and aircraft modification since Nov. 1, 1972, is given. The present aircraft (NC-141A,61-2775) and All Weather Landing System (AWLS) configurations are described along with the pilot procedures to be used initially in the Experimental Phase of the program. Individual mission reports are presented in Appendix A. Diagrams of each baseline approach are presented in Appendix B.

The primary conclusion is that the aircraft is ready for Category III Weather Flight Testing. Some discussion is presented on equipment specifications for CAT III landings.

Two areas are identified that need further developmental work:

1. For short runway operations and stop and go operations, an accurate Runway Distance Remaining Display is needed.

2. For zero visibility landings, the pilot requires some positive indication that the aircraft is almost stopped; otherwise the pilot tends to stop too abruptly, causing the aircraft to lurch violently at the moment of final stopping.

17. Key Words	18. Distribution Statement
All Weather Landing System CAT III Weather Flight Testing System Optimization Pilot Procedures	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151. PRICES SUBJECT TO CHANGE

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	142	5.75

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

FOREWORD

This report describes the results of the Optimization and Pre-experimental phases of the C-141 AWLS flight test program. Originally, separate reports were planned for definition of C-12 compass guidance and Litton LTN-51 inertial platform guidance approaches. Because of the obvious shortcomings of the C-12 system, it was decided to combine all of the AWLS optimization results into this one report.

The mission reports in Appendix A were written by the author and 2/Lt Michael J. Wilson. These reports and the monthly reports of the support contractor, Mr. John S. Kozina of Lear Siegler, Inc., were used to reconstruct the program history. The pilot procedures included were defined by the 4950th Test Wing test director, Capt Michael J. Lipcsey.

This technical memorandum has been reviewed and is approved.

LARRY M. HADLEY, LtCol, USAF
Chief, All Weather Landing Systems Branch
Flight Control Division

TABLE OF CONTENTS

INTRODUCTION

The C-141 All Weather Landing System (AWLS) has undergone a series of flight tests starting in 1968. The Lockheed-Georgia Co. performed a flight test of an AWLS Category III (Cat III) configuration in NC-141A, 61-2775, for the Federal Aviation Administration (FAA) at the National Aviation Facilities Experimental Center (NAFEC) in 1968-69. The objective of the flight test was to obtain adequate data to define minimum performance and equipment criteria for Category III operation and to identify existing system deficiencies which prohibited actual Category III operation. This test is reported in a NAFEC report, NA-69-18 (RD-69-34), dated October 1969. At the termination of the Lockheed-conducted flight test, 61-2775 was delivered to Aeronautical Systems Division (ASD) at Wright-Patterson AFB, Ohio, for continuation of the testing. The ultimate goal was to validate the C-141 AWLS for Category III operation.

The development of the C-141 AWLS was established as a joint USAF/FAA effort. The guidelines for working relations between the two organizations were defined in Interagency Working Agreement, DOT-FA70WAI-173, dated 11 Oct 69. This agreement, with twelve (12) modifications, is still in force.

The ASD (4950TW/EN) flight test lasted from 13 Dec 69 to 11 Apr 72. The results are reported in Flight Test Report ENE 72-20, dated 14 Nov 72. Unfortunately, the flight test objectives were never attained, since "The level of performance of the C-141 AWLS was so poor that the primary effort during this period of testing was forced to be directed, almost exclusively, toward trouble shooting and correcting AWLS problems." Although no conclusions pertaining to the flight test objectives could be made, it was recommended that a complete clean-up and updating of the AWLS be accomplished. It was specific that the clean-up include at least the installation of a dual inertial system (INS), installation of a modern flight control system, and elimination of all inputs to the AWLS from the C-12 compass system.

Accordingly, a contract was let to the Lear-Siegler, Inc. Contract Maintenance Facility at Mobile, Alabama, for the complete clean-up of the AWLS and the accomplishment of an aircraft periodic inspection. The aircraft was at Mobile for almost nine months. The first flight following the clean-up was on 26 Oct 72. After "safety of flight" discrepancies were corrected, the aircraft was returned to Wright-Patterson AFB on 1 Nov 72. The responsibility for test direction and management had been transferred to the Electronic Systems Division (ESD), and then was officially

transferred from ESD to the Air Force Flight Dynamics Laboratory (AFFDL) by Modification No. 9 of the Interagency Agreement.

Several efforts were begun simultaneously. The primary effort was to optimize the AWLS and the instrumentation, and to start a failure/degraded performance computer simulation. Also, the integration of the Maxson Independent Landing Monitor radar and the Sperry Electronic Attitude Director Indicator (ILM/EADI) was initiated. This report deals specifically with the actual AFFDL AWLS optimization flight tests.

AFFDL AWLS TESTS

Upon return to WPAFB on 1 Nov 72, the aircraft was grounded for the correction of a long list of aircraft and AWLS discrepancies, including an elusive fuel leak. It was discovered that an electrical loading problem between the INS and pilots' instruments (BDHI's) required the installation of ME-1A synchro signal amplifiers. This modification was accomplished at Wright Field (WPAFB, Area B) from 18 Jan to 30 Jan 73. During this same period, the main Test Power source was rewired to the downstream side of the #1 generator current sensor. Prior to this change, application of Test Power would cause the #1 generator to drop off the line. Several other loading problems were also corrected.

Following the ME-1A modification, it soon became obvious that the AWLS system components were not good enough to meet the requirements of CAT III operations. The CAT III system had been developed piecemeal through extensive modification of standard CAT II AWLS computers and the addition of a prototype Decrab computer.

Modifications had been incorporated in the following computers:

AFCS Coupler
AFCS Yaw Damper
AFCS Aileron Computer
Pilot's Flight Director Computer
Co-pilot's Flight Director Computer
Pilots Attitude Director Indicator (ADI)
Co-pilots Attitude Director Indicator

The modified components were unique to the system and were "one of a kind" items. Maintenance would have been extremely time consuming and expensive. Further, the components had been in operation since 1968, and age and handling had taken their toll. Only three of the original five ADI's were even partially working. To repair them would have cost almost as much as the purchase price of new ADI's, and since some necessary parts would not have been available for three months, would have caused significant program delays. Also, the Decrab Computer interface was, in part, accomplished by incorporating three large and cumbersome adapter boxes. All three were breadboarded models, and documentation was non-existent.

Due to these factors, it was decided to perform a second Class II modification to correct deficiencies. The modification accomplished the following:

a. The units listed below reverted to a standard CAT II AWLS item:

AFCS Coupler (later modified to optimize flare)
AFCS Yaw Damper
AFCS Aileron Computer
Pilot's Flight Director Computer
Co-pilot's Flight Director Computer

b. The pilot's and co-pilot's attitude director indicators were replaced by new production Sperry type AD-350B ADI's.

c. The Decrab computer and the three associated adapter boxes were removed.

d. The ADI interface and Decrab functions were incorporated in a newly designed CAT III Adapter. This unit utilized production state-of-the-art electronics and was constructed to model shop standards. At the same time, an AN/DPN-77 radar transponder and a localizer status monitor consisting of a display panel and an ARC-34 UHF radio receiver were installed. The entire Class II modification was accomplished between 1 April and 18 April 73. A functional check flight was flown on 19 April. The successful completion of the modification in such a short period of time was due to a splendid effort and cooperation between the AFFDL, 4950th TW, and the support contractor, Lear-Siegler, Inc. (LSI).

The aircraft departed for NAFEC, N.J. on 23 April 73 to perform a series of flights. The objectives of the mission were:

a. To determine the basic flyability of the provisional CAT III Instrument Landing System (ILS) at NAFEC.

b. To determine the effects of beam switching and course shifting on a CAT III airborne system.

c. To gather data for establishing a baseline for AWLS system performance.

d. To establish reliability and repeatability of the C-141 AWLS.

e. To gather data on ILS interference between the AWLS aircraft and other large aircraft.

f. To determine approach abort criteria and procedures through controlled fault analysis testing.

g. To train and re-qualify three FAA subject pilots.

The NAFEC mission was generally very productive, although all of the objectives were not met. Objectives a, b, and g were met, while objectives c, d, and e were only partially met. Objective f was not accomplished.

A combination of the ILS being off the air, AWLS system problems and out-of-limit winds caused many delays, and resulted in cancelling the fault analysis entirely. Decrab and rollout functions were not optimized, but system reliability was demonstrated down to the flare point. The mission actually accomplished a good clean-up of the Optimization Phase, excluding flare, decrab and rollout, but only a minimal amount of Pre-experimental Phase work.

The CAT III ILS facility tests were completed with no unexpected results. Glideslope and localizer beam switching with no beam offset caused no detectable perturbations to either the auto system or displays. Localizer beam switch with offsets of ±6 microamps (12 microamps from beam to beam - about 28 feet at the runway threshold) caused no fault trips of the AWLS monitors, and the autopilot was able to follow the obvious perturbations in all cases.

One potentially dangerous situation did occur. The aircraft, at 100 ft AGL, was offset to the left of the beam and was correcting right, back to the beam. At that point, the beam was switched 12 microamps to the right, causing the aircraft to increase its turn to the right. If allowed to continue, the aircraft would have touched down near the right runway edge with an excessive right lateral rate. This problem will be solved by the installation of an excessive lateral rate warning device prior to flights into zero-zero conditions.

Beam switch offsets of ±30 microamps (60 microamps from beam to beam) on the glideslope caused AWLS fault monitor trips in every case down to 200 feet, and in some cases between 100 and 200 feet. Beam switches below 100 feet caused no faults.

Beam interference tests included parked and moving ground vehicles, a taxiway parked 747 aircraft, and flying in-trail with a 747. The only obvious interference occurred when another aircraft overflew the localizer antenna, or when the AWLS aircraft was on the glideslope while another aircraft flew past the glideslope antenna upon landing.

After return to WPAFB from NAFEC on 23 May 73, several optimization flights were accomplished prior to the aircraft's departure to Robins AFB, Georgia, for a mandatory engine pylon modification. The aircraft returned from Robins AFB on 20 July and was entered into a 100 hour aircraft phase inspection.

Flight testing was resumed on 10 August. Eight missions were flown in August and September prior to going to NAFEC again for baseline data collection. Placing additional filters across the localizer receiver inputs to the autopilot coupler enabled the autopilot to track more accurately at low altitudes. Also, the roll to yaw cross-feed term from the aileron computer to the yaw damper computer was found to be missing. Correcting this deficiency resulted in significantly better localizer tracking. Further tracking problems have been attributed to inherent autopilot coupler design deficiencies.

During two weeks at NAFEC, 14 missions were flown. Since the flare and decrab were not fully optimized, the data gathered cannot be considered "baseline" data in the pure sense of the word. Combined with the flights which followed, however, a system performance estimation is possible. The approaches for which data is available are presented in Appendix B.

While at NAFEC, it was discovered that the glideslope window of the pilot's flight director system was ±75 microamps instead of the normal ±200 microamps. The small window made the allowable pilot error stackup so small that the manual pitch tracking task was more a matter of luck than skill. Baseline data on the manual task was deferred until the auto system is fully functional. The glideslope window problem was eventually solved by having the glideslope receivers balanced as a matched pair.

The constant high wind conditions encountered at NAFEC caused a significant drift when the decrab system engaged at 18 feet. It was decided to incorporate a lead roll term at decrab initiation, providing a wing-low approach.

It was also discovered that there were large localizer display oscillations at high engine RPM settings. This situation made the manual takeoff mode unusable. The problem was later traced to a bad coaxial cable "T" junction in the localizer antenna system.

After return to WPAFB on 21 September 73, and two missions for flare system troubleshooting, the aircraft entered a third major Class II Modification program on 15 October to install the EADI/ILM system, altitude and airspeed transducers, a bio-medical monitoring and recording system, camera installation and redesigned flare and decrab CAT III Adapter Interface. An outstanding cooperative effort resulted in an on-time completion on 11 Dec of both the modifications and a 100 hour aircraft phase inspection.

During and following the Class II Modification, the AWLS was put into final configuration. The entire AWLS was finalized as separate dual systems. There is no connection between the pilot's AWLS and the copilot's AWLS. Provisions were made for a lateral rate warning light and for a lateral rate display. Provisions were also made for a Runway Distance Remaining display.

Only four optimization flights were accomplished from 11 December 73 until the end of the year. A short trip to NAFEC was made for the purpose of flare and sideslip/rollout optimization, but an ice storm deposited an inch of ice over the aircraft and kept it grounded for three days. The final NAFEC missions (60 and 61) resulted in significant progress. The flare problem will be detailed in a separate report, as it is felt that a design deficiency exists in the normal C-141 autopilot coupler. Several flights were required in early 1974 to finish the optimization of the flare and sideslip/rollout. The results of these missions are recorded in Appendix A as Missions 62 through 79.

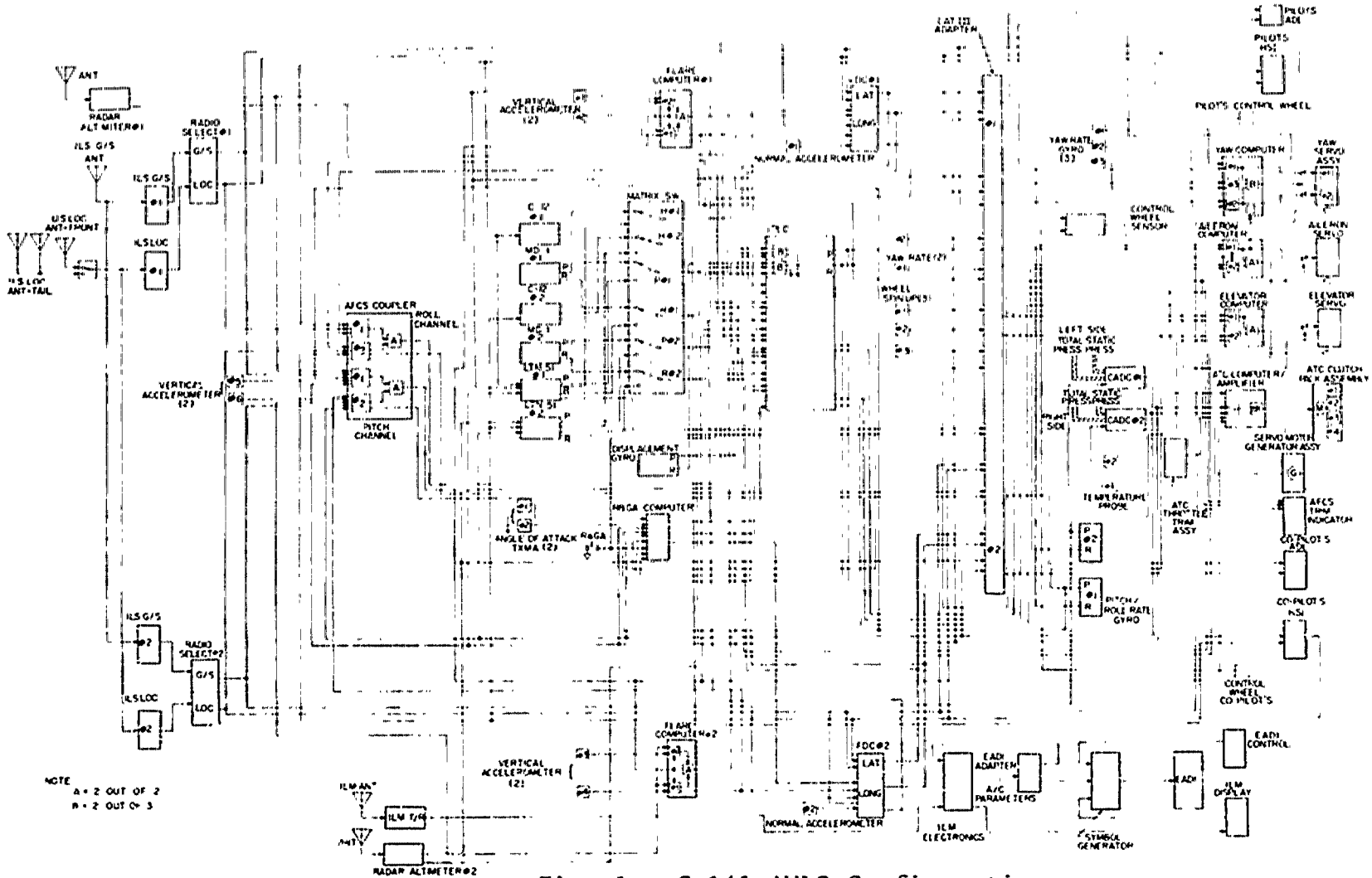


Fig. 1 - C-141 AWLS Configuration

AFFDL CAT III AWLS TEST CONFIGURATION

As a result of deficiencies noted during the ASD tests and initial flights of this test program, major modifications were made in the AWLS system. Rather than continuing the use of modified CAT II AWLS computers and substandard prototype components, it was decided to use standard CAT II AWLS computers, with all necessary additional circuitry being in one CAT III Adapter. The same adapter box also holds the circuitry necessary to interface the C-141 AWLS Flight Director Computers with new Sperry AD-340B ADI's.

The standard C-141 CAT II system provides:

a. Complete progress display through flare engagement.

b. System testing and monitoring through a Test Programmer and Logic Computer (TPLC).

c. Fault identification of the components.

d. Improved instrumentation for more accurate tracking.

The CAT II system is designed for control of the aircraft to touchdown, with no decrab or rollout information (i.e., see-to-land).

The initial modification required to convert to a CAT III AWLS system were as follows:

a. Installation of dual Inertial Navigation Systems (INS), which are used for heading and attitude reference. Later, they will also be used for ILS beam smoothing. By running the heading signals through ME-1A amplifiers, the inertial heading is degraded to approximate a good state-of-the-art compass system. At the time of original installation, a compass system accurate to ±.5 degree was not readily available. Modern compass systems, which provide the needed accuracy, are now being manufactured.

b. Installation of a CAT III Adapter, which is used to decrab (forward slip) and rollout the aircraft, and to interface Sperry AD-350B ADI's and other associated systems.

c. Installation of a second master caution control box with an associated six-light fault identification panel for display of manual steering faults in the pilot's system.

d. The replacement of two single channel glideslope and localizer receivers with dual output units with an expanded monitoring capability. The receivers used are standard in the C-5 aircraft.

e. The replacement of the Attitude Director Indicators (ADI) with Sperry AD-350B CAT III units containing additional displays for a fast/slow airspeed indicator, expanded localizer deviation, decrab and rollout commands.

f. The co-pilot's display now monitors Flight Director No. 2 instead of autopilot servo effort.

g. The angular pitch reference scale on the ADI is expanded from a 1:1 ratio to a non-linear scale, starting at 2.1:1 at 0 degrees and decreasing to 0.7:1 at 90 degrees of pitch.

h. Yaw rate and modified aileron follow-up circuits were added for the purpose of reducing pilot workload during an approach.

The system can be operated using either the INS or the C-12/MD-1 heading and attitude reference systems. This selection is made by one switch on the pilot's side console. It has been determined, however, that the C-12/MD-1 system is not accurate enough to perform the decrab/rollout function safely. The INS mode is, therefore, the primary mode for CAT III weather approaches.

There are two complete, separate systems installed in 61-2775. The No. 1 system feeds the pilot's instruments and a set of monitoring instruments at the Test Director's console in the rear of the aircraft. Faults in the No. 1 system are displayed on the pilot's six-light fault annunciator panel. The No. 2 system feeds the co-pilot's instruments and the autopilot. Faults in the No. 2 system are displayed on the 17-light fault annunciator panel. This panel also annunciates any discrepancy monitored by the TPLC. Below the decrab engage altitude, the TPLC can no longer disconnect the roll axis of the autopilot.

The EADI/ILM system was not used during the period covered by this report. A separate report on the EADI/ILM will be published at a later date.

A functional block diagram of the C-141 AWLS is presented in Figure 1. A complete technical report on the AWLS will be published at a later date.

In addition to the normal CAT II AWLS progress displays, several new displays were provided at the request of project pilots. At decrab engagement (18 ft), a blue light in the upper left corner of the ADI illuminates. At rollout engagement, a yellow light in the upper right corner of the ADI illuminates. Provisions have been made for a lateral rate warning light and display. At least the warning light will be installed prior to any zero visibility landings. A Runway Distance Remaining indicator will be built and installed when the electronic parts become available.

At typical test aircraft weights and approach speeds, the Rotate/Go-Around mode (R/G-A) commanded 15 degrees pitch up. This was uncomfortably steep for most pilots, so the computed angle of attack airspeed was increased to $1.3V_S$. Selecting the TAKEOFF position of the Takeoff Mode switch on the co-pilot's instrument panel brings the rudder command indicator into view to provide guidance to maintain localizer centerline. If the R/G-A button is then depressed, the pitch steering bar will command a takeoff flare at an angle of attack for $1.1V_S$, increasing to $1.3V_S$ when the rate of climb increases above 270 ft/min. At 18 feet AGL, the rudder command indicator will bias from view.

TEST PROCEDURES

The Optimization and Pre-experimental phases of the flight test have concurrent, with optimization of some systems continuing while pre-experimental tests were being conducted. Pilot procedures, for example, were decided upon prior to final rollout optimization.

The CAT III AWLS approach procedures used in baseline flights, and which will be used initially in the Experimental Phase are similar to CAT II AWLS procedures to 100 ft. AGL. As each progress light illuminates, the Safety Pilot (co-pilot) announces the milestone and any decision required at that point. The progress lights and their decision responses are:

1. LOC - "Loc Capture"

2. G/S - "Glideslope Capture"

3. APPR ARM - "Approach Arm Clear", if no fault lights illuminate at the end of the internal circuits preland test.

4. LAND ARM - "Land Arm", if no fault lights are illuminated.

5. FLARE - "Flare"

6. Decrab Light - "Decrab"

7. Rollout Light - "Rollout"

During a full stop landing, the Safety Pilot will call "Brakes" at 60 KIAS. During a touch-and-go, he will call "Go-Around" after the trim and flaps have been reset and he is advancing the power for takeoff. The Safety Pilot will set the power for takeoff. Any failure above 100 ft AGL requires a decision to continue manually or split axis, or to abandon the approach. Any AWLS failure below 100 ft AGL requires an immediate go-around. This arbitrary restriction was decided upon to standardize procedures from a flight safety standpoint. A third person, familiar with the system, will sit in the jump seat between the pilots specifically to monitor the fault annunciator panels and the lateral rate warning light. If a failure occurs in the No. 2 system, he will announce "Go-Around". If a failure occurs in the No. 1 system, he will announce "Manual 1, Go-Around. The No. 1 failure announcement requires the subject pilot to select ADI REPEAT before going around.

A pilot-in-the-loop computer simulation and a limited flight test failure/degraded performance analysis were completed to insure the safety of the procedures. The simulation is documented in ASD TR 74-29 while the results and analysis of the flight tests will be included in another report.

DISCUSSION OF RESULTS

As can be seen from the individual approach diagram in Appendix B, in September 1973, the following problems still required solutions:

a. The flare did not work properly. It was decided to abandon flare optimization due to time limitations. Because the auto flare was causing some nose gear landings, it was decided to have the Safety Pilot do the flare manually. Turning off the pitch axis at the flare point and making a visual landing (Safety Pilot) caused errors in the touchdown data. Most of this error occurred on runway 31, and is reflected in the larger data dispersion on that runway.

b. The decrab allowed large drift rates to occur.

c. The autopilot did not control rollout well enough by itself.

d. The pilots were not sufficiently familiar with the system to help the autopilot during rollout.

Since September, the following solutions have been implemented:

a. The flare problem has been solved by an autopilot coupler modification. A separate report is being prepared on this problem, as it is felt that it is an inherent design deficiency in all C-141 couplers.

b. A lead roll term was added to the decrab maneuver. This results in a wing low approach which retains the aircraft ground track at decrab. Since wind shear can cause the aircraft to be upwind, correcting downwind, at decrab, lateral rates still may be too high for comfortable touchdown. Rather than tie the autopilot to INS or doppler drift rate, it was decided to provide a warning light when the INS lateral rate exceeded a rate of 8.5 ft/sec in the touchdown zone. Tying the autopilot to localizer drift rate was considered too dangerous. Provisions have been made for a lateral drift rate display to supplement the warning light.

c. In order to obtain enough rudder authority to decrab efficiently and roll out smoothly, the rudder limitation of four degrees was increased to eight degrees, and then the gain was cut at touchdown. The pilot still has to enter the rudder control loop as the aircraft slows below approximately 60 knots and aerodynamic efficiency is lost.

d. The problem of pilot proficiency does not appear to be a major problem. Proficiency is gained rapidly, and the procedures have been developed specifically to remove decision (confusion) processes.

The following areas were found lacking during flight testing:

a. Some method of lateral rate display or warning should be provided if the aircraft does not automatically track to stop drift rate at decrab.

b. The touchdown point on the runway is not as important as the direction in which the aircraft is moving directly after touchdown. A specification on rollout lateral error from touchdown is required. It appears from the present data that the restriction need not be a tight one. A comfortable turn rate appears to provide sufficient tracking for safety.

c. For short runway operations and for stop-and-go operations, a Runway Distance Remaining display is needed.

d. For zero visibility landings, the pilot needs some notification that the aircraft is almost stopped. Otherwise, the aircraft lurches violently as it stops.

Note that an Independent Landing Monitor radar might solve these problems.

Table below presents the results of the baseline data flights at AFEC in September 1973. Individual approach data is presented in Appendix B.

TABLE 1

ADDAS TRACKING ERROR SUMMARY

(45 ft G/S from Theodolite Data)

Note: + = left of localizer center and above glideslope center (pilot's view).

WINDOW	MEAN (FT)	STD DEV (FT)	MAX (FT)	MIN (FT)
300 ft	LOC: 5.7	16.1	44	-39
	G/S: .7	6.4	14	-11
200 ft	LOC: 4.6	18.4	53	-41
	G/S:-0.9	5.8	10	-14
100 ft	LOC: 5.7	16.1	49	-24
	G/S: 0.4	4.0	9	-7
45 ft	LOC: 5.9	14.5	36	-22
	G/S: 1.4	4.0	7	-8
TOUCHDOWN FOOTPRINT:				
ALL DATA	LOC: 3.5	12.9	39	-20
From Threshold:	1578	---	2495	866
R/W 13	LOC: -1.6	11.7	17	-20
From Threshold:	1424	--	2157	866
R/W 31	LOC: 7.4	14.7	39	-19
From Threshold:	1752	--	2495	1303

95.9% of all touchdowns within $\pm$ 27 ft of centerline.

98% of all touchdowns within a 1500 ft touchdown zone.

All runway 13 touchdowns were within a ±27 x 1500 ft touchdown zone. The one runway 31 touchdown beyond the 1500 ft zone was a result of the Safety Pilot's visual flare. The two touchdowns outside the ±27 ft zone are unexplained, but may have been partially caused by the Safety Pilot trying to make a soft visual landing during a strong crosswind. It was because of these landings that the wing-low decrab was implemented.

All touchdowns were within the AC 20-57a safety requirements (longitudinally from 200 ft from the threshold to a point at which the last four bars of the touchdown zone lights can be seen - estimated at 2600 ft from the threshold. Laterally, the point which brings the outer landing gear to five feet from the edge of a 150 ft wide runway -60 ft to a C-141 centerline.

CONCLUSIONS AND RECOMMENDATIONS

1. The AWLS aircraft, NC-141A, 61-2775, is capable of safe flight operations in the Category III weather environment if the following restrictions are observed:

a. All landings in actual zero visibility weather be touch-and-go landings until a Runway Distance Remaining display is installed. It is possible that the Maxson ILM may eventually fulfill this requirement.

b. Initially, use a decision height based on a visual cue that is sufficient to determine lateral rate. As more information is gained about the low altitude regime, lower the decision height from 45 ft AGL (Flare engage) to 18 ft AGL (Decrab engage) to Touchdown - Rollout engage.

c. Prior to zero visibility landings (CAT IIIB), install a lateral rate warning device.

2. The C-12 compass system is not accurate enough to perform the decrab/rollout function safely. The INS (inertial guidance) mode should, therefore, be used as the primary mode for CAT III weather approaches.

APPENDIX A
MISSION REPORTS

The individual mission reports included in this appendix start with the first data flight at NAFEC on 12 Sep 73. They continue through the final optimization flights in Feb 74. The individual runs marked by an asterisk (*) were included as baseline data. Tracking data for these runs are presented in Appendix B.

MISSION NO. 43 DATE: 12 Sep 73 TIME: 2.0 TOTAL: 104.9

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, runway 13, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Five auto and five manual approaches were made. Two manual approaches resulted in go-arounds at low altitude due to G/S loss. During auto approaches, the aircraft drifts slightly left between G/S capture and APPR ARM, but then corrects and tracks well. NOTE: All landings were with tailwinds. The auto flare tends to over-flare and then stair-step down. The manual flare tends to under-flare. During manual approaches, the pilot has trouble tracking G/S below 100 ft (apparently due to a lack of G/S signal on the pitch steering bar (PSB) and the pitch up caused by ground effect.) During auto full stop landings, the pilot may need to aid the auto rollout with manual rudder inputs.

5. A Summary of the Runs Follows:

* Run 1 - White - Auto AWLS (no hood) - Wind 360/08. Went slightly left at G/S capture then corrected to centerline. Touchdown on centerline, went left, then corrected (with overshoot). T&G. 2-step flare.

Run 2 - White - Man AWLS (no hood). Good tracking. Got G/S MAN 2 fault just prior to flare. Went around. NOTE: Pilots did not notice position of raw G/S index at the time of failure.

Run 3 - White - Man AWLS (no hood). Wind 341/02/12. Loc caputre - slight overshoot with tailwind. G/S capture good. Went above G/S at 100 ft. Made correction and entered flare at steep angle. Hard landing. T&G.

* Run 4 - White - Auto AWLS (hood). Drifted left from G/S caputre to APP ARM, then corrected. Tracking good in turbulence. Touchdown about 15 ft left, then corrected to centerline. T&G. Definite 2-step flare (PSB also made 2-step) (Wind 02/12).

* Run 5 - White - Auto AWLS (hood). Wind 340/08. False loc capture caused turn to R/W heading. Loc and G/S captures good. Autothrottles worked hard in turbulence. T&G.

Run 6 - White - Man AWLS (hood). Wind 34V02/06. Touchdown slightly right. Good rollout. T&G.

* Run 7 - White - Auto AWLS (hood). Wind 34V02/10. Tracking good. Not quite enough flare. T&G.

* Run 8 - White - Auto AWLS (hood). Wind 35/12. Reverse caused large yaw. Pilot let autopilot control rollout. Ended up 60 ft left. Stop and go. NOTE: Safety pilot helped flare after nose dumped.

Run 9 - White - Man AWLS (hood). Wind 32/10. NOTE: No. 2 G/S light did not illuminate until APP ARM. Tracking good in turbulence. Got off G/S below 100 ft. Got G/S MAN 1 and G/S MAN 2 fault lights. Went around.

Run 10 - White - Man AWLS (hood). Wind 310/08. Excellent tracking at 1000 ft. Touchdown on centerline. Pilot anticipated flare - flared a couple of feet high. Safety Pilot added a bit of power. Good rollout. Full stop.

MISSION NO. 44 DATE: 12 Sep 73 TIME: 1.4 TOTAL: 106.3

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches runway 13, NAFEC.

3. Configuration: INS

4. Mission Synopsis: Excessive tailwinds caused early mission termination. The only good approach was the first practice approach (no hood).

5. A Summary of the Runs Follows:

NOTE: Aircraft lightweight.

* Run 1 - Cox - Auto AWLS (no hood). Tracking excellent. 3-step flare. Touchdown in slight left drift (towards centerline). T&G.

Run 2 - Cox - Man AWLS (no hood). Wind 34/12. Pilot lost G/S. Went around.

Run 3 - Cox - Man AWLS (no hood). One holding pattern on loc to allow F-106 take-off. Re-capture good. Wind 32/15. Tracking - went left and high at 100 ft. Got GS MAN 2 fault. Went around for winds and considerable turbulence.

Run 4 - Cox - Auto AWLS (hood). Tracking good in turbulence. 700 ft - A/P ROLL fault. Flew split axis. Wind 320/15. Touched down during correction to right. Safety Pilot aided rollout. T&G.

Run 5 - Cox - MAN AWLS (hood). Wind 33/10G15. APPR ARM - A/P ROLL and A/P PITCH faults. 707 aircraft landed on R/W 31 during preland test. Winds 34/14. Went around at flare.

Visual full stop (Lipcsey) - winds out of limits.

MISSION NO. 45 DATE: 13 Sep 73 TIME: 2.6 TOTAL: 108.9

1. Mission Objective: Demonstration flight.

2. Mission Profile: Pick-up passengers at Andrews AFB, fly multiple approaches at NAFEC and return to Andrews.

3. Configuration: INS.

4. Mission Synopsis: Two automatic touch-and-go landings followed by a manual full stop were made. After taxi-back, a hooded take-off was made. The video tape of the approaches was given to Lt Col Tinsley for viewing in Washington.

MISSION NO. 46 DATE: 14 Sep 73 TIME: 2.0 TOTAL: 110.9

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, runway 13, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Nine approaches were made. Four resulted in landings. The others were aborted due to the CAT II localizer being on. (CAT II loc antenna is located on short final for R/W 13). None of the approaches were included as baseline data due to the interference of the CAT II localizer.

5. A Summary of the Runs Follows:

Run 1 - Cox - Auto AWLS. Wind 130/12. T&G.

Run 2 - Cox - Auto/Manual AWLS. Wind 140/15. At 1000 ft AGL - A/P PITCH, A/P ROLL faults. Continued manual. Went around when pilot went left of loc. Note: G/S raw index was bouncing at failure.

Run 3 - Cox - Man AWLS. Overcorrected to the left on short final. Went around.

Run 4 - Cox - Auto AWLS. At 100 ft, the #1 raw and command loc info moved left. #2 continued to indicate correctly. T&G. NOTE: Safety Pilot caused flare to float.

Run 5 - Cox - Auto AWLS. At 100 ft, both loc displays deviated widly. Went around.

NOTE: Checked with TEST 1 - CAT II localizer was on. TEST 1 said it would be turned off.

Run 6 - Cox - Auto AWLS. CAT II loc still on. Erratic fluctuations in loc at 100 ft. Went around.

Run 7 - Cox - Auto AWLS. Wind 150/15. Drifted to about 20 ft left on rollout with chevron 1/8 in. right. T&G.

Run 8 - White - Man AWLS. Two overflights prior to G/S capture. Wind 170/13. Got slightly below G/S at 130 ft. Correction caused aircraft to fly up through G/S. #1 G/S tripped out at less than one dot. #2 G/S stayed in until 2 dots. Went around.

Run 9 - White - Auto AWLS. Wind 150/11. Full stop.

MISSION NO. 47 DATE: 14 Sep 73 TIME: .6 TOTAL: 111.5

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 13, NAFEC.

3. Configuration: INS - C-12/MD-1.

4. Mission Synopsis: Five approaches were flown with one go-around. The mission was terminated due to high winds, turbulence, and poor visibility. Flare was marginal.

5. A Summary of the Runs Follows:

* Run 1 - Johns - Auto AWLS. Wind 140/12. T&G. No ADDAS.

* Run 2 - Johns - Auto AWLS. Wind 130/14. T&G.

Run 3 - Johns - Man AWLS. Wind 140/20. Went high on G/S (Autothrottles added to level-off tendency). Went around.

Run 4 - Johns - Man AWLS. Wind 130/18. Only got 2 wheel spin-ups at touchdown on wet runway. Spoilers were deployed manually. Full stop.

NOTE: Switched to C-12/MD-1.

Run 5 - Johns - Auto AWLS. NOTE: In HEADING SELECT, autopilot only made 10 deg of bank. Wind 130/18G25. Turbulence caused by winds of 30-40 knots led to decision to terminate. No tracking - aircraft not visible on final. Auto decrab was correct, but did not satisfy chevron. Full stop.

MISSION NO. 48 DATE: 15 Sep 73 TIME: 3.3 TOTAL: 114.8

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 31, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Eleven approaches and landings were made with a strong right crosswind. Tracking did not seem to be as tight as with a left crosswind. The #1 G/S receiver failed - used the #2 G/S receiver in the #1 position for manual approaches.

5. A Summary of the Runs Follows:

NOTE: On takeoff, the chevron did not appear to give correct commands to the loc.

* Run 1 - White - Auto AWLS. Wind 350/10. Touchdown slightly leftbounced. T&G.

Run 2 - White - Man AWLS. Wind 010/10. Good flare, but bounced slightly. Pilot did not keep chevron centered throughout rollout. Also, right wing lifted slightly. T&G.

* Run 3 - White - Auto AWLS. Wind 360/10. Over-decrab - 2 deg. Rollout stayed left. T&G.

* Run 4 - White - Auto AWLS. Wind 020/07. Stop and go. NOTE: UH-1 took off on R/W 04 during flare - caused violent loc movements.

* Run 5 - White - Auto AWLS. #1 G/S flag in view. APPR ARM - G/S MAN 1 fault. Continued in ADI REPEAT. T&G.

Run 6 - White - Man AWLS. Stop and go. (Stopped at 5500 ft to go).

* Run 7 - White - Auto AWLS. #1 G/S flag in view. APPR ARM - G/S MAN 1 fault. Continued in ADI REPEAT. Wing 360/12. 15 micro-amps standoff until 100 ft. Touchdown 10 micro-amps left. T&G.

* Run 8 - White - Auto AWLS. Wing 070/12. #1 G/S flag in view. APPR ARM - G/S MAN 1 fault. Touchdown 15 micro-amps left. Good correction. T&G.

NOTE: Traded G/S receivers.

Run 9 - White - Man AWLS. #2 G/S flag in view. APPR ARM - G/S MAN 2 fault. Wind 040/12. T&G.

Run 10 - White - Man AWLS. Wind 04/12. APPR ARM - G/S MAN 2 fault. Pilot appeared to drop flare when he decrabbed. Stop and go. NOTE: Traded G/S receivers to original position.

* Run 11 - White - Auto AWLS. APPR ARM - G/S MAN 1 fault. Wind 010/09. Went from 14 micro-amps left at 500 ft to slightly right at 200 ft. The correction for being right caused a left drift. Touchdown 45 ft left. Good rollout correction. T&G.

NOTE: Localizer 3 micro-amps left on runway at 5000 ft. remaining. Visual Full Stop (Lipcsey).

MISSION NO. 49 DATE: 17 Sep 73 TIME: 2.0 TOTAL: 116.8

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 13, NAFEC.

3. Configuration: C-12/MD-1. Replaced No. 1 G/S receiver.

4. Mission Synopsis: No. 1 INS failed prior to takeoff. Eight approaches were made to R/W 13; one was made to R/W 04. Winds were a left cross, 10G20, causing turbulence. The pilot was unable to maintain the G/S below 100 ft on R/W 13. He had no problem on R/W 04.

5. A Summary of the Runs Follows:

* Run 1 - Stephens - Auto AWLS. Wind 04/13. 4 deg of crab cut to 2 deg by auto decrab. T&G.

Run 2 - Stephens - Man AWLS. Wind 06/17. Went above G/S at 100 ft. Got G/S MAN 1 fault. Went around.

Run 3 - Stephens - Man AWLS. Wind 07/15. Turbulence caused pitch changes which resulted in going below, then above the G/S. Got G/S MAN 1 fault. Went around.

* Run 4 - Stephens - Auto AWLS. Wind 09/15. Went below, then above G/S at 100 ft. Touched down with 5 deg left crab (Safety Pilot tried to help decrab and flare, but was not fast enough). T&G. Pilot did not keep rollout chevron centered.

* Run 5 - Stephens - Auto AWLS. Wind 110/14. Touchdown left - decrab and flare were acceptable. Stop and go. NOTE: Got chevron commands to go to left on takeoff.

Run 6 - Stephens - Man AWLS. Went above G/S at 100 ft. Got G/S MAN 1 fault. Went around.

* Run 7 - Stephens - Auto AWLS. Wind 07/14. No apparent flare - hard landing. T&G.

NOTE: Safety Pilot decided that flare problems and wind conditions preclude auto landings. Test request - manual approach to runway 04 to look at G/S tracking.

Run 8 - Stephens - Man AWLS (R/W 04). Wind 07/12. Pilot was able to track G/S all the way to flare. Low approach.

* Run 9 - Stephens - Auto AWLS (R/W 13). Wind 09/14. Aircraft took off, R/W 13, just at APPR ARM. Got G/S MAN 1 fault just prior to flare. Safety Pilot turned off pitch and helped flare. Drifted 50 ft left during rollout - then corrected. Full stop.

NOTE: Tower called winds 070/10G20.

MISSION NO. 50 DATE: 17 Sep 73 TIME: 1.9 TOTAL: 118.7

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 13, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: The No. 1 INS worked, but by the end of the mission had drifted 2nm vs the 1/2 nm for No. 2. Eight approaches were made - 6 auto and 1 manual on R/W 04. The pilot was unable to track to the flare point on R/W 13, but had no problem on R/W 04. The flare was not as rapid as in previous missions, but was unacceptable. Loc tracking appeared to be degrading throughout the day's 2 missions, but the aircraft always corrected to center by 300 ft.

5. A Summary of the Runs Follows:

* Run 1 - Lamprecht - Auto AWLS. Wind 09/15. At 100 ft, G/S raw index went 1/2 dot up, then 1/2 dot down. T&G. NOTE: Pilots prefer to not use the take-off switch on T&G landings because it is an extra cockpit movement.

* Run 2 - Lamprecht - Auto AWLS. Wind 100/10. Tracking-left standoff until 200 ft. T&G.

Run 3 - Lamprecht - Man AWLS. Vectored through the loc course by Appr Control. Recapture good. Wind 110/14. LAND ARM - G/S MAN 1, FLARE 2, LAND ARM faults. Went around.

* Run 4 - Lamprecht - Auto AWLS. Left tracking until 100 ft. Touchdown in slight right drift. Stop and go.

* Run 5 - Lamprecht - Auto AWLS. Wind 09/13. A/P Pitch off during flare. Pilot finished flare manually. Much better flare. Stop and go. Note: Pilot did not keep chevron centered during takeoff.

Run 6 - Lamprecht - Man AWLS - R/W 04. No problem on G/S tracking. T&G.

* Run 7 - Lamprecht - Auto AWLS - R/W 13. At G/S capture, aircraft turned 3 deg left, went 20 microamps left, then corrected after APPR ARM. APPR ARM - no faults in spite of overflight. Wind 100/08. Left tracking bias. Stop and go. Good takeoff. Note: Flare by Safety Pilot.

* Run 8 - Lamprecht - Auto AWLS. Wind 090/15. Left tracking bias with 5 deg right drift. Safety Pilot made flare. Good rollout. Full stop. Note: Pilot said that knowledge that flare would be made by Safety Pilot made the tracking job easier on short final.

MISSION NO. 51 DATE: 18 Sep 73 TIME: 1.6 TOTAL: 120.3

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 13, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Five auto approaches were made before weather caused termination.

5. A Summary of the Runs Follows:

* Run 1 - Stephens - Auto AWLS. Wind 24/12. Safety Pilot flared. T&G.

* Run 2 - Stephens - Auto AWLS. Safety Pilot made flare - said A/C over-decrabbed. Full stop, taxi-back. NOTE: On takeoff, chevron initially took A/C too far left. Safety Pilot had to help. A Caribou took off in front of us.

* Run 3 - Stephens - Auto AWLS. Auto flare - 2-step. T&G.

Run 4 - Stephens - Auto AWLS. Tracking excellent. Wind 280/09. Wind shear at 200 ft caused right drift. Crossed threshold 50 ft. right. Corrected back during Safety Pilot's flare. Stop and go.

Run 5 - Stephens - Auto AWLS. Lost ADDAS. Safety Pilot made long flare. Initial auto decrab did not center chevron; chevron was centered by the time we touched down. T&G.

NOTE: 6 F-106's returning to NAFEC caused a delay. It was decided to terminate due to weather and ADDAS loss.

Visual landing (Lipcsey).

MISSION NO. 52 DATE: 18 Sep 73 TIME: 2.2 TOTAL: 1225

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 31, NAFEC.

3. Configuration: INS - One G/S receiver was replaced inflight.

4. Mission Synopsis: Six auto and three manual approaches were made. Tracking on the loc was excellent (with a direct headwind). The glideslope had noticeable excursions below 200 ft. The No. 1 FDC trips G/S MAN 1 with less than one dot excursion of the G/S marker.

5. A Summary of the Runs Follows:

* Run 1 - Lamprecht - Auto AWLS. Safety Pilot flared manually. T&G.

Run 2 - Lamprecht - Man AWLS. Wind 300/10. Lost G/S at 120 ft (G/S MAN 1 fault). Went around.

Run 3 - Lamprecht - Man AWLS. Wind 310/10. Lost G/S at 120 ft - G/S index was centered. G/S MAN 1 fault. Went around.

* Run 4 - Lamprecht - Auto AWLS. Wind 320/12. No. 2 G/S flag did not pull until 8nm. G/S markers did not agree until centered. Touchdown left, good correction. T&G.

Run 5 - Lamprecht - Man AWLS. At 100 ft, went 1/4 dot low on G/S, corrected and went 3/4 dot high - got G/S MAN 1 fault.

* Run 6 - Lamprecht - Auto AWLS. Wind 310/12. G/S moves down at 200 ft and 120 ft. Stop and go.

* Run 7 - Lamprecht - Auto AWLS. Below 200 ft, there are several G/S excursions. T&G.

* Run 8 - Lamprecht - Auto AWLS. Stop and go.

* Run 9 - Lamprecht - Auto AWLS. Tried auto flare - Safety Pilot had to help it. Full stop termination.

MISSION NO. 53 DATE 19 Sep 73TIME 2.3 TOTAL: 124.8

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 31, NAFEC.

3. Configuration: C-12/MD-1.

4. Mission Synopsis: The No. 1 FDC was replaced. It allowed a slightly larger approach window without faulting G/S MAN 1. When power was applied for takeoff, the localizer displays oscillated violently. (The oscillations stop when power is reduced.) Use of the C-12 compass system causes decrab overshoots due to improper heading information.

5. A Summary of the Runs Follows:

NOTE: On takeoff the chevron commanded left rudder until the aircraft was 30 ft left of centerline.

* Run 1 - Stephens - Auto AWLS. Wind 020/07. Got G/S MAN 2, A/P PITCH faults at flare. (Safety Pilot turned off A/P PITCH.) Went around.

* Run 2 - Stephens - Auto AWLS. Wind 01/07. G/S receivers have slightly different gradients and nulls. Drifted left during Safety Pilot's flare. T&G.

Run 3 - Stephens - Man AWLS. Wind 360/09. Got G/S MAN 1 light flicker just prior to flare. Safety Pilot made flare. T&G.

* Run 4 - Stephens - Auto AWLS. Wind 340/09. Noisy G/S at low altitude. Stop and go.

NOTE: At power run-up for takeoff, the loc displays oscillated violently. Reducing power eliminated oscillations.

Run 5 - Stephens - Man AWLS. Wind 05/07. Lost G/S at 100 ft. Went around. NOTE: Less than 1 dot below G/S at loss (G/S MAN 1, G/S MAN 2 faults).

Run 6 - Stephens - Auto AWLS. Wind 36/06. Stop and go. NOTE: Ran up engines individually. Each caused loc display oscillations above EPR 1.6.

Run 7 - Stephens - Man AWLS. Wind 02/08. T&G. Pilot did not decrab.

Run 8 - Stephens - Auto AWLS. Wind 310/05. T&G.

Run 9 - Stephens - Man AWLS. Wind 310/08. Lost G/S at 100 ft. (PSB was off 1/2 to 1 bar width several seconds prior to loss.) Went around.

Visual pattern to full stop landing. (Lipcsey)

MISSION NO. 54 DATE: 19 Sep 73 TIME: 1.5 TOTAL: 126.3

1. Mission Objective: Baseline Data.

2. Mission Profile: Multiple ILS approaches, R/W 13, NAFEC.

3. Configuration: C-12/MD-1.

4. Mission Synopsis: The system did not correct to beam center during rollout. It was decided to cancel the next mission for ground trouble-shooting.

5. A Summary of the Runs Follows:

* Run 1 - Lamprecht - Auto AWLS. Wind 23/07. R/G-A came on momentarily. Went around. When Safety Pilot turned off A/P PITCH early, he thought A/P PITCH light was G/S MAN 1.

* Run 2 - Lamprecht - Auto AWLS. R/G-A fault came on momentarily. Drifted left during flare. T&G.

* Run 3 - Lamprecht - Auto AWLS. Wind 16/08. Drifted left during Safety Pilot's flare. Stop and go. NOTE: At high engine RPM, all loc displays oscillate. Unable to use chevron during takeoff.

* Run 4 - Lamprecht - Auto AWLS. Over-decrab 2 deg. NOTE: C-12 No. 1 reads high vs. INS. T&G.

Run 5 - Lamprecht - Auto AWLS. Wind 16/08 Landed left and stayed left (15 micro-amps). Stop and go.

* Run 6 - Lamprecht - Auto AWLS. Wind 13/10. APPR ARM - no faults. Chevron kept us 15 micro-amps left. Full stop, termination.

MISSION NO. 55 DATE: 20 Sep 73 TIME: 2.2 TOTAL: 128.5

1. Mission Objective: Baseline Data/Troubleshoot

2. Mission Profile: Multiple ILS approaches, R/W 13 and R/W 31, NAFEC.

3. Configuration: C-12/MD-1 and INS.

4. Mission Synopsis: Six C-12/MD-1 approaches were made with varying degrees of success. The decrab and rollout modes bias left, apparently due to inaccurate compass headings. During rollout, the autopilot does not use large enough rudder inputs to center the chevron. The last three approaches were in the INS mode. and were noticeably improved. During the last two approaches, the pilot helped to keep the chevron centered, resulting in excellent rollouts.

5. A Summary of the Runs Follows:

Run 1 - Lamprecht - Auto AWLS. Wind 270/10. Touchdown on centerline. Drifted left 30 ft, then corrected. NOTE: Expanded loc showed that loc was left of centerline at touchdown. T&G. No tracking on this run.

Run 2 - Lamprecht - Auto AWLS. Wind 260/15. Rollout corrections appear sluggish. T&G.

Run 3 - Lamprecht - Auto AWLS. Wind 28/12. Stop and go. Chevron not kept precisely centered during rollout.

NOTE: Changed to Runway 31.

Run 4 - Lamprecht - Auto/Man AWLS. A 747 took off during the Preland test. APPR ARM - A/P ROLL fault. Flew split axis. Safety Pilot made flare. T&G. Pilot made aileron correction toward chevron at decrab. Wind 26/10. NOTE: Chevron and autopilot appear to bias left when on centerline. Chevron then moves right, but autopilot does not follow. C-12 No. 1 reads 1 deg above INS No. 1. C-12 No. 2 reads 3 deg high.

* Run 5 - Lamprecht - Auto AWLS. Wind 320/10. Got G/S MAN 1 and G/S MAN 2 faults at flare as Safety Pilot turned off A/P PITCH. Went around.

* Run 6 - Lamprecht - Auto AWLS. Wind 300/15. Touchdown 15 micro-amps right - corrected through course. Autopilot did not follow chevron closely. T&G.

NOTE: Switched to INS.

* Run 7 - Lamprecht - Auto AWLS. Wind 310/14. Touchdown 13 micro-amps left - corrected to center, then went left. Chevron went right, then autopilot followed. T&G.
NOTE: No. 2 wheel spin-up light was slow to light.

* Run 8 - Lamprecht - Auto AWLS. Drove 15 micro-amps left between G/S capture and APPR ARM, then corrected to center. Touchdown on centerline. T&G. Wind 30/08.

* Run 9 - Lamprecht - Auto AWLS. Wind 300/14G19. Touchdown and rollout near centerline. T&G.

Visual landing. (Lipcsey)

MISSION NO. 56 DATE: 21 Sep 73 TIME: 1.0 TOTAL: 129.5
Ferry Time: 1.5

1. Mission Objective: Baseline Data/Troubleshoot.

2. Mission Profile: Multiple ILS approaches, R/W 31, NAFEC. Return to WPAFB.

3. Configuration: INS.

4. Mission Synopsis: Four approaches were flown using the INS mode to confirm that the problems in C-12 tracking do not occur in INS tracking. Tracking, with a variable right crosswind, was obviously better.

NOTE: On takeoff for the ferry flight to WPAFB, the No. 1 wheel spin-up light did not illuminate until 110 kts.

5. A Summary of the Runs Follows:

* Run 1 - Stephens - Auto AWLS. Wind 03/12. Decrab from 312 to 309 deg. T&G.

* Run 2 - Stephens - Auto AWLS. Wind 04/10. Decrab to 308.8° (INS 2). T&G.

* Run 3 - Stephens - Auto AWLS. Chevron does not center during auto decrab. It appears to be a correct display. T&G.

* Run 4 - Stephens - Auto AWLS. Wind 08/11. Full stop, termination.

MISSION NO. 57 DATE: 5 Oct 73 TIME: 2.5 TOTAL: 132.0

1. Mission Objective: Flare Troubleshooting.

2. Mission Profile: Multiple ILS approaches at Cox, runway 6L.

3. Configuration: INS.
RAD ALT input to flare computer was filtered.

4. Mission Synopsis: Eight approaches were flown in the INS mode at Cox-Dayton airport to troubleshoot the flare computer. Various filters were tried on the output of the Radar Altimeter with varying success. The flares still stair-stepped.

5. A Summary of the Runs Follows:

Run 1 - Green - Auto AWLS. Wind 36/12. RAD ALT, LAND ARM and FLARE fault lights due to unanticipated loading of the RAD ALT circuits by test equipment. Missed approach. Go-around.

Run 2 - Green - Man AWLS. Wind 36/12. RAD ALT, LAND ARM, and FLARE fault lights, same reason as run 1. T&G.

Run 3 - Green - Auto AWLS. Wind 36/12. T&G. No assist - two step flare - Rollout assisted. No apparent wind.

Run 4 - Green - Auto/Man AWLS. Wind CALM. Auto-throttle will not engage, intermittent. No flight director on Co-pilot's side. RAD ALT, LAND ARM, FLARE, A/P ROLL, A/P PITCH, THROT fault lights. Continued manual approach. T&G.

Run 5 - Green - Auto AWLS. Wind 36/8. T&G no assist. Landed 20 feet left of centerline, stayed on left side of runway. Flare good.

Run 6 - Green - Auto AWLS. Wind 10/10. T&G no assist. Landed 20 feet left of centerline. Corrected back to centerline, then to left of runway. Pilot took over manually. Hard landing.

Run 7 - Green - Auto AWLS. Wind 10/10. T&G no assist. Landed 15 feet left of centerline, rollout straight. Two step flare, landed in proper attitude.

Run 8 - Green - Auto AWLS. Wind 10/10. A/P ROLL fault light, reason undetermined. ATC directed Go Around.

MISSION NO. 58 DATE: 12 Oct 73 TIME: 2.2 TOTAL: 134.2

1. Mission Objective: Check Flare, Troubleshooting.

2. Mission Profile: Multiple ILS approaches at WPAFB, runway 23.

3. Configuration: INS. Matched LOC receivers installed prior to flight. Shields terminated on RAD ALT output. Additional filters installed on RAD ALT output.

4. Mission Synopsis: Eight automatic AWLS approaches were flown in the INS mode at WPAFB, Ohio, runway 23 to perform additional troubleshooting on the flare computer. The steps in the flare were not as pronounced as in the previous mission. In fact, the aircraft actually flared very little.

5. A Summary of the Runs Follows:

Run 1 - Green - MAN AWLS. Wind 22/10. G/S not armed - continued manual. T&G.

Run 2 - Green - Auto AWLS. Wind 22/14. Unassisted T&G - landed 25 ft left - rollout straight - two step flare, not too hard.

Run 3 - Green - Split Axis AWLS. Wind 24/14. APPR ARM-A/P PITCH fault light - continued approach with manual pitch. T&G.

Run 4 - Green - Split Axis AWLS. Wind 24/14. APPR ARM-A/P PITCH fault light - pitch flown manually - no flare indication on pilot's ADI. Landed centerline, steered left on rollout. T&G.

Run 5 - Green - Auto AWLS. Wind 21/12. T&G unassisted - flare computer changed, LOC oscillations - minimum flare but landing not too hard - landed centerline, steered left on rollout.

Run 6 - Green - Auto AWLS. Wind 24/10. T&G unassisted - no flare noticed, landing not too hard though. Landed left and stayed left.

Run 7 - Green - Auto AWLS. Wind 21/10. Stop and go unassisted - A B52 on final 4 miles ahead caused violent LOC oscillations. Minimal flare, solid landing - landed and stayed left.

Run 8 - Green - Auto AWLS. Wind 21/10. Full stop termination, unassisted - no flare, hard landing.

MISSION NO. 59 DATE: 13 Dec 73 TIME: 2.6 TOTAL: 136.8

1. Mission Objective: Flare Optimization and trouble-shooting - procedure practice.

2. Mission Profile: Multiple automatic ILS approaches to runway 13, NAFEC.

3. Configuration: C-12/MD-1
All approaches were made five knots high due to gusts.

4. Mission Synopsis: Ten automatic approaches were made to runway 13 at NAFEC. The C-12 system was used due to the INS being inoperative. This was the first AWLS flight after the Nov. '73 class II Mod was completed. A phase inspection was also completed during this Mod. The wing-low decrab has been incorporated as well as some changes to the flare computer. The decrab worked quite well after the LOC term was removed from the decrab maneuver. However, even after several adjustments the flare was still poor, stepped, and too little. Overall, the tracking was good.

5. A Summary of the Runs Follows:

Run 1 - Johns - Auto AWLS. Wind 15/14. T.O. mode used, no LOC interference. Chevron commanded left when aircraft was centered. INS's differ by 15°, switched to C-12. T&G, wing-low decrab wrong way, rate high, go around.

Run 2 - Johns - Auto AWLS. Wind 15/18. T&G - manual decrab - Little flare, hard landing, bounced. Roll fault, pilot assisted.

Run 3 - Johns - Auto AWLS. Wind 17/15G25. No runway contact, no flare - safety pilot initiated go around. De-crab looked good.

Run 4 - Johns - Auto AWLS. Wind 17/18G25. Flare gain increased - T&G - Stepped flare - Pilot assisted touchdown. Aligned with centerline, decrab looked good.

Run 5 - Johns - Auto AWLS. Wind 17/15. Flare gain readjusted - T&G - Stepped flare, less step than previous run, pilot assisted touchdown. Landed slightly left. Decrab good.

Run 6 - Johns - Auto AWLS. Wind 13/17. Flare gain reduced - LOC term removed from decrab maneuver. Flare pitched up, then dumped nose. Pilot initiated go-around. Landed 5-10 ft right. Decrab good.

Run 7 - Johns - Auto AWLS. Wind 18/17. T&G - Good decrab - Poor flare - Pilot initiated Go-around.

Run 8 - Johns - Auto AWLS. Wind 18/17. Flare gain increased - T&G - Unassisted flare, dropped nose, landed hard. 10 ft left.

Run 9 - Johns - Auto AWLS. Wind 18/20. T&G - An F-106 on short final caused us to go one dot low on the G/S, however, no fault occurred. Flare, nose dumped, pilot assisted - on centerline.

Run 10 - Johns - Auto AWLS. Wind 19/20. Full stop - Pilot assisted flare - touched down in slight crab.

MISSION NO. 60 DATE: 15 Dec 73 TIME: 2.6 TOTAL: 139.4

1. Mission Objective: Flare Optimization and troubleshooting.

2. Mission Profile: Multiple ILS approaches to runway 31, NAFEC.

3. Configuration: INS auto.

4. Mission Synopsis: Eleven approaches were flown to runway 31 at NAFEC. The INS was operative and working properly. Several changes were made in attempt to improve the flare. The flare was still unsatisfactory.

5. A Summary of the Runs Follows:

Run 1 - Lipcsey - MAN AWLS. Wind 31/7. T&G - Auto-Pilot tripped off during preland check. Continued manual approach.

Run 2 - Lipcsey - Split Axis AWLS. Wind 31/7. APPR ARM - A/P PITCH fault light - continued with manual pitch - landed 10 ft left. T&G.

Run 3 - Lipcsey - Auto AWLS. Wind 33/7. T&G - Slight nose drop on flare, then pilot assisted - landed 15 ft left - unassisted rollout - rollout weak.

Run 4 - Lipcsey - MAN AWLS. Wind 01/8. A/P PITCH, A/P ROLL fault light at LAND ARM. Continued manual approach. T&G.

Run 5 - Lipcsey - Auto AWLS. Wind 34/7. T&G - Unassisted landing - good flare - landed slightly left - Chevron still commanded more left on rollout.

Run 6 - Lipcsey - Auto AWLS. Wind 32/7. T&G - little flare, pilot assisted - landed hard, 10-15 ft right.

Run 7 - Lipcsey - Auto AWLS. Wind 32/8. T&G - Coupler card changed, Flare better - landed approximately on centerline.

Run 8 - Lipcsey - Auto AWLS. Wind 33/7. Variable. T&G - Still insufficient flare.

Run 9 - Lipcsey - Auto AWLS. Wind 31/10. T&G - Flare gain increased - flare slightly stepped - 10 ft left.

Run 10 - Lipcsey - Auto AWLS. Wind 31/7. T&G - two stepped flare, landing good-20 feet left.

Run 11 - Lipcsey - Auto AWLS. Wind 32/8. Full stop - Stepped flare - landing not too bad, 5 ft left.

MISSION NO. 61 DATE: 19 Dec 73 TIME: 3.0 TOTAL: 142.4

1. Mission Objective: Flare Optimization and Fault Analysis.

2. Mission Profile: Multiple ILS approaches to runway 31, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Thirteen automatic approaches were flown to runway 31 at NAFEC in the INS mode. All approaches were unassisted. The coupler was modified prior to this mission. The flare gain was adjusted during flight. The flare was much improved, the best it has ever been. The flare, decrab, and rollout tracking were all quite acceptable.

5. A Summary of the Runs Follows:

Run 1 - Johns - Auto AWLS. Wind 36/8. T&G - unassisted landing - Good flare, on centerline.

Run 2 - Johns - Auto AWLS. Wind 01/8. T&G - Good flare - landed 5 ft left then tracked 10 ft right, then 20 ft left. Unassisted flare and rollout.

Run 3 - Johns - Auto AWLS. Wind 02/6. T&G - 15% reduction in flare gain - landed 10 ft right, corrected to left, overshot centerline 10 ft. Good flare, landing a little harder.

Run 4 - Johns - Auto AWLS. Wind 01/8. T&G - Flare integrator rate increased from 1.5 to 1.7, rollout rate decreased. Landed on centerline - good flare - decrab good.

Run 5 - Johns - Split Axis AWLS. Wind 01/8. T&G - flare integrator rate increased from 17. to 2.0. - Rollout rate decreased from 40% to 20%. G/S capture too close in. A/P ROLL fault. Manual roll and decrab. Flare good.

Run 6 - Johns - Auto AWLS. Wind 02/8. T&G - landed 15 ft left, corrected to centerline, flare good.

Run 7 - Johns - Auto AWLS. Wind 02/6. T&G - flare good - rollout good. Touchdown at 8500 ft marker, rotate at 5000 ft marker.

Run 8 - Johns - Auto AWLS. Wind 0[illegible]6. T&G - 20% increase in rudder gain. Landed 15 ft left, corrected to centerline, rollout good - flare good, a little harder. 4000 ft rollout.

Run 9 - Johns - Auto AWLS. Wind 01/8. T&G - manually assisted rollout. Rollout maintained within 5 ft of centerline. Flare good.

Run 10 - Johns - Auto AWLS. Wind 10/7. T&G - landed 5 ft left, corrected to centerline - rollout good - flare good, firm.

Run 11 - Johns - Auto AWLS. Wind 01/8. T&G - tracking and flare very good.

Run 12 - Johns - Auto AWLS. Wind 34/10. T&G - FAULT ANALYSIS - LOC failed on rollout to check INS tracking. Pilot's ADI display disappeared. A/C tracked on copilot's ADI. Landed 10 ft left, corrected center.

Run 13 - Johns - Auto AWLS. Wind 36/9. T&G - FAULT ANALYSIS - Flare and tracking very good.

Run 14 - Johns - VFR recovery.

MISSION NO. 62 DATE: 7 Jan 74 TIME: 3.0 TOTAL: 145.4

1. Mission Objective: Flare, Decrab and rollout optimization.

2. Mission Profile: Multiple ILS approaches to runway 23, WPAFB.

3. Configuration: INS.

4. Mission Synopsis: Twelve automatic approaches were flown to runway 23 at Wright-Patterson AFB in ths INS mode. In-flight changes were made to the flare gain, integrator rate, ramp gain, aileron gain for the decrab maneuver, and the LOC course rate gain. By the end of the flight the flare and decrab were quite acceptable. The rollout is still not good.

5. A Summary of the Runs Follows:

Run 1 - Lipcsey - Auto AWLS. Wind 28/10. T&G - unassisted landing - On T.O. rising runway and chevron oscillating - landed left. Crab at 18 ft: 0.8°/At TD: 2.4° - Slight stepped flare, good landing - no wing-low decrab.

Run 2 - Lipcsey - Auto AWLS. Wind 27/12. T&G - 15% increase in aileron gain of decrab maneuver - ramp gain decreased 10%. Crab at 18 ft: 0.4°/At TD: 0.2° - Flare good, less stepped - Rollout good.

Run 3 - Lipcsey - Auto AWLS. Wind 27/10. T&G - 10% decrease in ramp gain - Flare slightly stepped, landing good. Crab at 18 ft: 0.8°/At TD: 1.7°.

Run 4 - Lipcsey - Auto AWLS. Wind 25/08. T&G - 10% increase in ramp gain - Flare gain decreased 10% - Crab at 18 ft: 3.2°/At TD: 0.2°. Shallow approach - Flare and decrab very good- FLARE and LAND ARM lights out (copilot's).

Run 5 - Lipcsey - Split Axis AWLS. Wind 24/10. T&G - No change - A/P PITCH, G/S MAN 2 fault lights at approach arm, continued approach with manual pitch - Traffic on runway - Crab at 18 ft: -/At TD: 0.4°.

Run 6 - Lipcsey - Auto AWLS. Wind 25/08. T&G - Crab at 18 ft: 2.5°/At TD: 2.5°. Copilot's G/S flag stayed out too long. Landed on centerline then steered left. Flare good.

Run 7 - Lipcsey - Auto AWLS. Wind 27/10. T&G - Crab at 18 ft: 2.6°/At TD: 0.8° - Flare and Decrab good - Roll-out left.

Run 8 - Lipcsey - Auto AWLS. Wind 27/10. T&G - Flare gain decreased 5%. Crab at 18 ft: 3.7°/At TD: 2.5° - Flare good, a little harder - Decrab okay - rollout good, pilot assisted below 100 kts.

Run 9 - Richmond - Split Axis AWLS. Wind 26/14. T&G - Flare gain decreased 5%. A/P PITCH, G/S MAN 2 fault lights at APP ARM, Pitch flown manually - two step flare - Power fluctuations at landing due to #3 CSD.

Run 10 - Richmond - Auto AWLS. Wind 29/12. T&G - LOC course gain decreased from 20 to 10. Crab at 18 ft: 4.0°/At TD: 3.3° - Landed hard, flare okay, rollout good.

Run 11 - Richmond - Auto AWLS. Wind 27/12. T&G - Integrator gain adjusted from 2.0 to 1.5 - Crab at 18 ft: 3.5°/At TD: 2.7° - Flare good, firm landing.

Run 12 - Richmond - Auto AWLS. Wind 27/08. Full stop recovery - Pilot assisted rollout at 60 kts - Crab at 18 ft: 2.0°/At TD: 4.5°. Flare good.

MISSION NO. 63 DATE: 8 Jan 74 TIME: 2.2 TOTAL: 147.6

1. Mission Objective: Check Decrab and rollout maneuver. Pilot Proficiency.

2. Mission Profile: Multiple ILS approaches to runway 6L, Cox-Dayton.

3. Configuration: INS.

4. Mission Synopsis: Six auto ILS approaches were flown to runway 6L at Cox-Dayton in the INS mode. The flare is now working quite acceptably. Decrab was insufficient to non-existent. On rollout the rudder gain is too high, e.g., corrects too rapidly and therefore overcorrects. Also, on rollout the left wing remains at least 3° low whether correcting left or right.

5. A Summary of the Runs Follows:

Run 1 - Stevens - Auto AWLS. Wind 05/05. T&G - no change since last mission - Flare good - Decrab insufficient, no wing low. Landed 40 ft left, corrected to centerline rapidly. Left wing down on rollout.

Run 2 - Stevens - Auto AWLS. Wind 11/12. T&G - Flare good - Insufficient Decrab - TD 20-25 ft left, then corrected to 40 ft right, then to centerline. Left down on rollout.

Run 3 - Stevens - MAN AWLS. Wind 10/14. T&G - Full manual approach - Good approach, flare good. TD on centerline, straight rollout.

Run 4 - Lamprecht - Auto AWLS. Wind 09/12. T&G - Decrab poor - rollout 55 ft left, safety pilot assisted rollout. Left wing 3° low on rollout.

Run 5 - Lamprecht - MAN AWLS. Wind 10/10. T&G - Hard landing - no decrab - landed 15 ft right - left wing 3° low on rollout.

Run 6 - Lamprecht - Auto AWLS. Wind 11/12. T&G - Flare good - 6° right crab decreased to 3° right crab at TD. Left wing went down slightly. During rollout from 40 ft left to 40 ft right, left wing was 3° low while control yolk was held 20° right.

MISSION NO. 64 DATE: 10 Jan 74 TIME: 1.5 TOTAL: 149.1

1. Mission Objective: Decrab and Rollout Optimization, Flare Observations.

2. Mission Profile: Multiple ILS approaches to Runway 6L at Cox-Dayton.

3. Configuration: INS.

4. Mission Synopsis: Six automatic AWLS approaches were made to runway 6L at Cox-Dayton Airport. The purpose of this mission was to check the decrab and rollout modes. However, the crosswind component was so slight that it was insufficient to check the system. It appeared that the rudder was not following the chevron commands on rollout. The runway conditions were quite icy.

5. A Summary of the Runs Follows:

Run 1 - Johns - Split Axis AWLS. Wind 02/08. APPR ARM - FLARE, A/P PITCH fault light - continued with manual pitch. No Decrab, No Rollout. T&G.

Run 2 - Johns - Auto AWLS. Wind 04/7. T&G - landed 10 ft left - flare good - rollout good.

Run 3 - Johns - Auto AWLS. Wind 04/10. T&G - Flare good - On centerline - Rollout good - appeared to put wrong wing down on decrab - 2 sec delay in wheel spin up. At touchdown, Crab angle: 0; Drift angle: 0.

Run 4 - Johns - Auto AWLS. Wind 04/8. Go-around - No runway contract. Flare fault - Rad Alt jumped 100 ft at FLARE.

Run 5 - Johns - Auto AWLS. Wind 04/6. T&G - Flare good - On centerline - Rollout to left - Chevron commanded right but got no response from A/P. Little or no Decrab. At touchdown, crab angle: .7; drift angle: .7.

Run 6 - Lipcsey - Auto AWLS; Wind 04/8. T&G - On centerline - rollout very close to centerline. At touchdown, crab angle: -.9; drift angle: .1.

Run 7 - Lipcsey - GCA recovery to WPAFB.

MISSION NO. 65 DATE: 11 Jan 74 TIME: 2.3 TOTAL: 151.4

1. Mission Objective: Decrab & Rollout Optimization.

2. Mission Profile: Multiple ILS approaches to runway 6L, Cox-Dayton.

3. Configuration: INS.

4. Mission Synopsis: Ten automatic AWLS approaches were flown to runway 6L at Cox-Dayton in the INS mode. The rudder gain was adjusted in flight. The decrab maneuver seems much improved and with the exception of run #10 was working very well. The auto-rollout still lacks authority and allows the aircraft to get approximately 40 ft off centerline before correcting. The manually assisted rollouts were good, within 10 ft of centerline.

5. A Summary of the Runs Follows:

Run 1 - Lamprecht - Auto AWLS. Wind 30/8. T&G - T.O. mode used - EMI encountered at EPR of 1.45. Coupler course rate gain changed to orginal value. On centerline. Rollout good.

	At 20'	TD
INS Hdg:	51.0	54.0
Crab:	5.0	1.9

Run 2 - Lamprecht - Auto AWLS. Wind 30/8. T&G - no change. TD on centerline - Rollout 10' left.

	At 20'	TD
INS Hdg:	50.5	54.0
Crab:	5.5	2.0

Run 3 - Lamprecht - Auto AWLS. Wind 30/8. T&G - Landed 15' left - corrected slowly to centerline.

	AT 20'	TD
INS Hdg:	52.4	52.8
Crab:	36	3.2

Run 4 - Lamprecht - Auto AWLS. Wind 30/10. T&G - Landed 20' left - Pilot assisted latter part of Rollout.

	At 20'	TD
INS Hdg:	52.0	55.0
Crab:	4.3	2.1

Run 5 - Lamprecht - Auto AWLS. Wind 30/10. T&G - Pilot assisted rollout - TD and rollout within 5' of centerline.

	At 20'	TD
INS Hdg:	50.9	54.0
Crab:	5.1	2.3

Run 6 - Stevens - Auto AWLS. Wind 29/10. T&G - Rudder gain increased to Max gain. TD 20' left - slight correction to centerline - decrab more pronounced.

	At 20'	TD
INS Hdg:	52.5	50.1
Crab:	3.5	.4

Run 7 - Stevens - Auto AWLS. Wind 30/10. T&G - Landed centerline drifted 40' left then slowly corrected back to centerline unassisted, weak rollout correction.

	At 20'	TD
INS Hdg:	51.7	54.5
Crab:	5.0	1.9

Run 8 - Stevens - Auto AWLS. Wind 29/9. T&G - Pilot assisted rollout - Rollout within 10' of centerline TD. 15' right. On centerline at decrab - appeared to over decrab.

	At 20'	TD
INS Hdg:	51.4	55.5
Crab:	5.0	1.9

Run 9 - Stevens - Auto AWLS. Wind 29/10. T&G - Rudder gain decreased 10% - A/P Roll fault - Manual decrab - Traffic on T.O. TD 20' left. Pilot assisted Rollout.

	At 20'	TD
INS Hdg:	49.1	52.7
Crab:	6.5	4.1

Run 10 - Stevens - Auto AWLS. Wind 29/30/8. T&G - Little Decrab - no wing low.

	At 20'	TD
INS Hdg:	52.4	53.1
Crab:	4.1	3.4

MISSION NO. 66 DATE: 14 Jan 74 TIME: 3.3 TOTAL: 154.7

1. Mission Objective: Decrab and Rollout Optimization. Night familiarization.

2. Mission Profile: Multiple ILS approaches to runway 23 at WPAFB, Ohio.

3. Configuration: INS. Fixed resistors installed in the flare card of the coupler. Take-off mode used - EMI (LOC fluctuations) encountered at an EPR of 1.7.

4. Mission Synopsis: Twelve AWLS approaches, nine automatic and three manual, were flown to runway 23 at WPAFB, Ohio. This was the first night AWLS mission. The COURSE RATE & YAW LOC gains were adjusted in flight in an attempt to improve the rollout mode. Some improvement was noted. The auto-rollout still lacks authority. The decrab maneuver appeared to decrab in the wrong direction at times. However, the crosswind component was so slight that it was insufficient for a reliable check of this maneuver.

5. A Summary of the Runs Follows:

Run 1 - Johns - Auto AWLS. Wind 23/13. T&G - Rudder gain - 100%, Yaw LOC - 20%, Course rate gain - 40%. T.D. 30 ft left, rollout stayed 30 ft left, straight. Smooth landing.

	At 20'	TD
INS Hdg:	228.8	228.7
Crab:	2.4	0.5

Run 2 - Johns - Auto AWLS. Wind 22/10. T&G - YAW LOC - 30%. T.D. 15 ft left - partially corrected to centerline, within 5 ft R/GA fault light flashed on intermittently during entire approach.

	At 20'	TD
INS Hdg:	229.1	228.7
Crab:	1.4	1.5

Run 3 - Johns - Auto AWLS. Wind 21/10. T&G - YAW LOC gain increased to 35% - TD 10 ft left - rollout 20 ft left, then corrected to centerline. Overcorrected a little.

	At 20'	TD
INS Hdg:	229.2	227.9
Crab:	1.5	2.2

Run 4 - Johns - Auto AWLS. Wind 23/11. T&G - YAW LOC gain decreased to 30%. TD 5 ft left. Rollout 30 ft left, then corrected to centerline. Stayed between centerline and 25 ft left.

	At 20'	TD
INS Hdg:	229.6	228.3
Crab:	1.5	1.7

Run 5 - Johns - Auto AWLS. Wind 22/13. T&G - COURSE RATE gain decreased to 30%. TD 5 ft left, rollout between centerline and 20 ft left.

	At 20'	TD
INS Hdg:	229.3	228.6
Crab:	0.9	2.2

Run 6 - Johns - Split Axis AWLS. Wind 22/10. T&G - No change - A/P PITCH fault at APPR ARM. Continued with manual pitch - TD 20 ft left. Corrected to centerline. Rollout between 15 ft left and centerline.

	At 20'	TD
INS Hdg:	229.1	227.9
Crab:	0.7	1.8

Run 7 - Johns - Auto AWLS. Wind 22/12. T&G - YAW LOC gain increased to 40%. TD 10 ft left. Rollout between 20 ft left and 5 ft right, gradually progressed to right. Right aileron on decrab.

	At 20'	TD
INS Hdg:	229.3	228.1
Crab:	0.7	1.6

Run 8 - Johns - Auto AWLS. Wind 23/10. T&G - RUDDER gain decreased to 90%. Decrab better. TD 10 ft left. Rollout oscillated between 20 ft left and centerline.

	At 20'	TD
INS Hdg:	228.8	230.0
Crab:	2.1	0.5

Run 9 - Johns - MAN AWLS. Wind 22/13. T&G - no change - TD on centerline - Rollout oscillated between 40 ft left and 30 ft right.

Run 10 - Johns - MAN AWLS. Wind 23/10. T&G - TD 15 ft right - Rollout within 15 ft left and 15 ft right, Flare good.

MISSION NO. 67 DATE: 18 Jan 74 TIME: 2.6 TOTAL: 157.3

1. Mission Objective: Decrab and Rollout Optimization. Investigate LOC oscillations at high engine power settings.

2. Mission Profile: Multiple ILS approaches to runway 23, WPAFB, Ohio.

3. Configuration: C-12. INS #2 failure during alignment.

4. Mission Synopsis: Nine automatic AWLS approaches were flown to runway 23 at WPAFB, Ohio. The C-12 system was utilized, as INU 0361 failed during alignment. The decrab initiation altitude was increased to 200 ft to check the decrab maneuver more accurately. The decrab maneuver was found to be quite acceptable and the decrab engage altitude reset to 18 ft. The auto-rollout is not acceptable, roll-outs were way left of centerline. The system still lacks authority in this mode. The CAT III adapter will be checked and aligned before the next flight. The LOC interference problem seems to be in the LOC antenna coax cables or connectors.

5. A Summary of the Runs Follows:

Run 1-Lipcsey - Auto AWLS. T&G - Assisted Rollout - TD 10 ft left - Rolled out left when chevron commanded right. No LOC noise on rollout.

Run 2 - Lipcsey - Auto AWLS. T&G - TD on centerline - rollout left - no aileron on decrab though decrab very subtle. No LOC noise.

Run 3 - Lipcsey - Auto AWLS. T&G - TD 10 ft left - rollout way left - Decrab good.

Run 4 - Lipcsey - Auto AWLS. T&G - Decrab good - TD very smooth - rollout left - C.R. gain decreased 40% to 20% before this approach.

Run 5 - Lipcsey - Auto AWLS. T&G - Hdg error gain 50% to 60%. TD 15 ft left - rollout left.

Run 6 - Lipcsey - Auto AWLS. T&G - YAW LOC gain increased 30% to 50%. TD 10 ft left - Rollout engage delayed. Decrab seemed okay.

Run 7 - Lipcsey - Split Axis AWLS. APPR ARM - A/P PITCH fault light - continued with manual pitch - TD on centerline - landing bounced. Landed in left crab. T&G.

Run 8 - Lipcsey - Auto AWLS. T&G - Decrab engage height increased to 200 ft. Manual AWLS from 100 ft. Decrab good. Wheel spin-up delayed.

Run 9 - Lipcsey - Auto AWLS. T&G - Decrab good. Roll-out way left.

Run 10 - Lipcsey - Full stop termination - Non AWLS ILS approach manual landing.

MISSION NO. 68 DATE: 22 Jan 74 TIME: 3.0 TOTAL: 160.3

1. Mission Objective: Decrab and rollout optimization. Check LOC noise - take approach photographs of Indianapolis Muni.

2. Mission Profile: Multiple ILS approaches to runway 23, WPAFB, Ohio, and runway 4L, IND.

3. Configuration: C-12.

4. Mission Synopsis: Seven automatic AWLS approaches were flown, four to runway 23, WPAFB, and three to runway 4L at Indianapolis. The C-12 compass was utilized for all approaches. The YAW LOC, rudder, and rudder LOC rate and aileron gains were adjusted in flight. The Rollout is much improved but could be better. On the last rollout, the aircraft stayed within 15 ft of runway centerline. There is a considerable difference in the rollout at WPAFB runway 23 and Indianapolis runway 4L, (CAT I and CAT II beams). It is much tighter on the CAT II beam. Replacing the T-connector in the LOC receiver antenna coax seems to have solved the LOC oscillation problem. No LOC oscillations were experienced.

5. A Summary of the Runs Follows:

Run 1 - Johns - Auto AWLS. Wind 15/4. T&G - TD 10 ft left - rollout 85 ft left - did not follow chevron - wheel spin-up 2 & 3 immediately - Decrab to left.

Run 2 - Johns - Auto AWLS. Wind 16/8. T&G - YAW LOC gain increased 30%. Rudder gain increased 20% - Pilots HSI set to 250°. TD 15 ft left - rollout 25 ft - insufficient rudder gain - A/P did not follow chevron.

Run 3 - Johns - Auto AWLS. Wind 15/6. T&G - Rudder gain increased 30%. TD 20 ft left - rollout better - yaw damper failed on rollout - caused by large lateral rate - little decrab.

Run 4 - Johns - Auto AWLS. Wind 17/8. T&G - Runway 4L - TD 15 ft left course error corrected rapidly to right - overcorrected 25 ft right. Yaw damper fault during rollout - excessive course cut.

Run 5 - Johns - Auto AWLS. Wind 15/8. T&G - Runway 4L IND - Yaw LOC gain decreased to 50% - Rudder LOC rate gain adjusted to 40% - TD 20 ft left - corrected to centerline - correction much smoother - Divergent on later part of rollout.

Run 6 - Johns - Auto AWLS. Wind 15/8. T&G - Runway 4L IND - Aileron gain decreased 10% - Yaw LOC decreased to 35% - Rudder gain decreased 15%. TD 20 ft left - Rollout better, within 15 ft of centerline.

Run 7 - Johns - Auto AWLS. Wind 18/6. Full stop termination to runway 23, WPAFB - TD 20 ft right with left heading error - corrected way left - overshot centerline - Pilot assisted final rollout - Decrab good.

MISSION NO. 69 DATE: 24 Jan 74 TIME: 2.7 TOTAL: 163.0

1. Mission Objective: Rollout Optimization.

2. Mission Profile: Multiple ILS approaches to runway 6L, Cox-Dayton.

3. Configuration: C-12.

4. Mission Synopsis: Thirteen automatic AWLS approaches were flown to runway 6L, Cox-Dayton. The C-12 compass system was used. The Yaw LOC and Yaw LOC rate gains were adjusted in flight. The auto-rollout is much improved, within +10 ft of centerline. However, the system still needs to be checked in a strong crosswind.

5. A Summary of the Runs Follows:

Run 1 - Richmond - Auto AWLS. Wind 19/3. T&G - TD 10 ft left - Rollout 20 ft left - then corrected to centerline.

Run 2 - Richmond - Auto AWLS. Wind 19/4. T&G - TD 15 ft right - rollout between 15 ft right and centerline - decrab good -059 set in pilot's HSI window.

Run 3 - Richmond - Auto AWLS. Wind 19/3. T&G - Pilot intentionally displaced aircraft from centerline on rollout - pilots input tripped A/P off. TD 15 ft right - manual rollout.

Run 4 - Richmond - Auto AWLS. Wind 19/3. T&G - TD 10 ft right - A/P tripped off on rollout. Decrab good.

Run 5 - Richmond - Auto AWLS. Wind 19/4. T&G - Manual rollout - Safety pilot intentionally displaced A/C on rollout - TD 2 ft left - Pilot corrected 20 ft left, then 5 ft right of centerline.

Run 6 - Richmond - Auto AWLS. Wind 18/4. T&G - Yaw LOC gain decreased 15% - Yaw LOC rate increased. TD centerline - manual rollout - overcorrected.

Run 7 - Richmond - Split Axis AWLS. Wind 18/4. T&G - Yaw LOC increased to 30% - A/P ROLL fault light at APPR ARM - A/C overflight of LOC transmitter - continued with manual roll - Go around at 50 ft.

Run 8 - Richmond - Auto AWLS. Wind 19/2. T&G - Manual rollout - TD 5 ft left - intentionally displaced 45 ft left - Pilot overcorrected on rollout.

Run 9 - Richmond - Auto AWLS. Wind 15/4. T&G - Yaw LOC rate increased to 80% - Manual rollout. TD centerline. Rollout better but still overcorrected.

Run 10 - Richmond - Auto AWLS. Wind 15/4. T&G - TD centerline - rollout within 10 ft of centerline. Pilot assisted slightly on rollout.

MISSION NO. 70 DATE: 25 Jan 74 TIME: 3.2 TOTAL: 166.2

1. Mission Objective: Rollout Optimization.

2. Mission Profile: Multiple ILS approaches to runway 6L, Cox-Dayton.

3. Configuration: INS.

4. Mission Synopsis: Ten automatic AWLS approaches were flown to runway 6L, Cox-Dayton. The rudder gain was adjusted in flight. The rollout, both automatic and manual, was much improved. The ADDAS recorder was not operating for this mission due to a malfunction.

5. A Summary of the Runs Follows:

Run 1 - Lipcsey - Auto AWLS. Wind 21/6. T&G - TD on centerline. Rollout within 5 ft of centerline.

Run 2 - Lipcsey - Auto AWLS. Wind 21/6. Rudder gain increased 30%. ATC directed go around.

Run 3 - Lipcsey - MAN AWLS. Wind 20/6. T&G - Flare fault light at APPR ARM - G/S MAN 2 fault. Continued with manual approach.

Run 4 - Lipcsey - Auto AWLS. Wind 19/8. T&G -TD 5 ft left - rollout within 10 ft of centerline.

Run 5 - Lipcsey - Auto AWLS. Wind 22/7. T&G - Rudder gain increased 30% - TD and rollout within 5 ft of centerline.

Run 6 - Lipcsey - Auto AWLS. Wind 22/7. T&G - Manual rollout - 20 ft intentional lateral displacement on initial rollout. TD 30 ft left - rollout converged after 2-3 oscillations.

Run 7 - Lipcsey - Auto AWLS. Wind 22/7. T&G - Manual rollout - TD centerline - rollout good.

Run 8 - Lipcsey - Auto AWLS. Wind 20/8. T&G - Manual rollout - intentional displacement - rollout good.

Run 9 - Lipcsey - Auto AWLS. Wind 20/8. T&G - Manual rollout - no intentional displacement. TD on centerline - rollout within 20 ft of centerline. Some overshooting.

Run 10 - Lipcsey - Auto AWLS. Wind 20/8. T&G - Unassisted auto rollout - TD 10 ft left - rollout within 5 ft of centerline.

Run 11 - VFR Recovery to WPAFB.

MISSION NO. 71 DATE: 30 Jan 74 TIME: 1.9 TOTAL: 168.1

Ferry time, FFO to WRI: 1.5

1. Mission Objective: Check Rollout in Crosswind.

2. Mission Profile: Multiple ILS approaches to runways 13 and 31, NAFEC. Launch and recovery at McGuire AFB, N.J.

3. Configuration: INS.

4. Mission Synopsis: Five automatic AWLS approaches were attempted to runway 31 and one to runway 13, NAFEC. However, none were successful due to the fact that both ILS transmitters were operating simultaneously resulting in an A/P disconnect at approximately 100 ft.

MISSION NO. 72 DATE: 31 Jan 74 TIME: 2.4 TOTAL: 170.5

1. Mission Objective: Check Rollout.

2. Mission Profile: Multiple ILS approaches to runway 31 at NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Seven AWLS approaches were flown to runway 31 at NAFEC to check the rollout in a strong crosswind. However, none of the approaches resulted in a complete auto landing and rollout. The crosswind was quite strong (18-25 knots) and moderate turbulence was evident. The A/P disconnects on every approach indicate the system's inability to cope with this crosswind level and associated turbulence.

5. A Summary of the Runs follows:

Run 1 - Lipcsey - Auto AWLS. Wind 24/18. A/P ROLL fault at APPR ARM - continued with manual roll - go around at 100 ft.

Run 2 - Lipcsey - MAN AWLS. Wind 25/20. T&G - A/P PITCH, and flare faults at land ARM - no decrab - manual landing 15 ft left.

Run 3 - Lipcsey - Auto AWLS. Wind 24/22. A/P PITCH, A/P ROLL and flare faults at land ARM - go-around.

Run 4 - Lipcsey - MAN AWLS. Wind 23/22. T&G - Coupler changed - A/P PITCH at APP ARM. Multiple faults at Land ARM - manual landing.

Run 5 - Lipcsey - Auto AWLS. Wind 23/21. A/P PITCH fault at APPR ARM - land ARM and flare fault at land ARM-go-around.

Run 6 - Lipcsey - Auto AWLS. Wind 23/25. Coupler changed - A/P PITCH, flare and land ARM faults at land ARM - go-around.

Run 7 - Lipcsey - Auto AWLS. Wind 23/25. #2 flare computer changed - A/P PITCH, flare and land ARM faults at land ARM - go-around.

MISSION NO. 73 DATE: 1 Feb 74 TIME: 3.8 TOTAL: 174.3

1. Mission Objective: Check Rollout - Investigate and correct faults that occurred on previous 2 missions. Fault analysis.

2. Mission Profile: Multiple ILS approaches to runway 1, Dover and runway 31, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Thirteen AWLS approaches were flown to runway 1 Dover and runway 31 NAFEC. On eight approaches to NAFEC, the LOC transmitter was failed on TD to determine pilot and system performance in the back-up, heading only, rollout mode. Results were varied but indicate that heading only guidance is acceptable for back-up rollout. The pilot was wired for Bio-Med data this mission.

5. A Summary of the Runs Follows:

F.A. = Fault Analysis

Run 1 - Richmond - Auto AWLS. Wind 27/8. T&G - Dover runway 1, TD 8 ft left - roll to centerline. Decrab good.

Run 2 - Richmond - Auto AWLS. Wind 31/6. T&G - Dover, runway 1 - Decrab, TD and rollout good.

Run 3 - Richmond - Auto AWLS. Wind 28/6. T&G - Dover, runway 1 - TD right - rollout way left.

Run 4 - Richmond - Auto AWLS. Wind 31/10. Full stop - NAFEC 31 - TD 8 ft right - rollout good - within 5 ft of centerline - pilot assisted rollout.

At 20'	TD
305.0	306.0

Run 5 - Richmond - MAN AWLS. Full stop - NAFEC 31 - G/S down for maintenance by ground crew - manual landing - 30 min ground time.

Run 6 - Richmond - Auto AWLS. Wind 27/10. Full stop - F.A. failed LOC transmitter on TD - rollout on Hdg only - pilot assisted - rollout within 10 ft of centerline - stopped on centerline.

Run 7 - Richmond - Auto AWLS. Wind 29/10. Full stop - F.A. flare fault at flare - go around.

Run 8 - Richmond - Auto AWLS. Wind 27/10. Full stop - F.A. - failed LOC transmitter on TD - TD 15 ft left - rollout straight.

Run 9 - Janssens - Auto AWLS. Wind 31/8. Full stop - F.A. - failed LOC transmitter on TD. TD 30 ft left - rollout 35 ft left. Wheel spin-up erratic.

Run 10 - Janssens - Auto AWLS. Wind 31/8. Full stop - F.A. - failed LOC transmitter on TD. TD 80 ft left - go-around by safety pilot.

Run 11 - Janssens - Auto AWLS. Wind 30/7. Full stop - F.A. - LOC transmitter failed on TD. TD centerline with left course error - rollout 80 ft left - stopped 70 ft left.

Run 12 - Janssens - Auto AWLS. Wind 27/7. Full stop - F.A. - LOC transmitter failed on TD. TD 30 ft left - roll-out straight - stopped 30 ft left.

Run 13 - Janssens - Auto AWLS. Wind 27/6. Full stop - F.A. - LOC transmitter failed on TD. TD 15 ft left - roll-out 70 ft left.

MISSION NO. 74 DATE: 2 Feb 74 TIME: 3.4 TOTAL: 177.7

1. Mission Objective: Check rollout and verify system. Fault analysis.

2. Mission Profile: Multiple ILS approaches to runway 13 and 31 NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Twelve AWLS approaches were flown to runways 13 and 31 at NAFEC. The Yaw LOC, Yaw rate and aileron gains were adjusted in flight in attempt to improve the rollout. Some problems existed with the ILS transmitters, but the situation was corrected towards the latter part of the mission. The rollout was improving on the later approaches.

5. A Summary of the Runs Follows:

Run 1 - Lipcsey - Auto AWLS. Wind 06/10. 13 NAFEC - LAND ARM; flare, A/P PITCH faults at LAND ARM - go around - No TD.

Run 2 - Lipcsey - Auto AWLS. Wind 05/12. T&G - 13 NAFEC - LAND ARM, Flare and A/P PITCH fault at LAND ARM - full stop - manual landing for maintenance.

Run 3 - Lipcsey - Auto AWLS. Wind 05/12. 13 NAFEC - changed R.T. units and calibrated - Land arm, ILS transmitter failed - go around - no TD.

Run 4 - Lipcsey - Auto AWLS. Wind 05/10. T&G - 31 NAFEC - TD 15 ft left - manual rollout - Decrab good.

Run 5 - Lipcsey - Auto AWLS. Wind 15/10. T&G - 31 NAFEC - Yaw LOC decreased 15% - Yaw Rate increased 15% - TD 10 ft left - rollout within 15 ft of centerline - decrab good.

Run 6 - Lipcsey - Split Axis AWLS. Wind 04/10. T&G - 31 NAFEC - A/P PITCH at APPR ARM - manual pitch. TD 15 ft left - A/P disconnected on rollout - manual rollout.

	At 20'	TD
INS Hdg:	312	307.8

Run 7 - Lipcsey - Auto AWLS. Wind 04/10. T&G - 31 NAFEC - TD 15 ft left - excessive course cut on rollout tripped yaw damper off. Manual rollout. Decrab good.

	At 20'	TD
INS Hdg:	312	307.8

Run 8 - Lipcsey - Split Axis AWLS. Wind 06/12. T&G-31 NAFEC - wing down term decreased 20% - A/P ROLL fault at 400 ft - Flare #1 at APPR ARM - Manual roll - TD left.

Run 9 - Lipcsey - Auto AWLS. Wind 06/13. T&G - 31 NAFEC - 5 ft left at decrab - 15 ft left at TD - rollout 20 ft left then 15 ft right, then overshot centerline again.

Run 10 - Janssens - Auto AWLS. Wind 05/15. T&G - 31 NAFEC - on centerline at flare - TD 30 ft left - rollout 40 ft left, corrected to centerline - oscillated.

Run 11 - Janssens - Auto AWLS. Wind 03/16. Yaw LOC rate to 100% - excessive drift rate - go-around.

MISSION NO. 75 DATE: 6 Feb 74 TIME: 3.5 TOTAL: 181.2

1. Mission Objective: Rollout and Tracking Optimization.

2. Mission Profile: Multiple ILS approaches to runway 19R and 1R, Dulles Int.

3. Configuration: INS. New INS platform installed prior to this mission.

4. Mission Synopsis: Three AWLS approaches were flown to runway 19R and four approaches to runway 1R at Dulles Int. and one full stop approach to runway 13, NAFEC. These approaches were very impressive. The tracking, flare, decrab, and rollout were all quite acceptable, especially in view of the fact that the approaches to runway 1R were with a quartering tailwind.

5. A Summary of the Runs Follows:

Run 1 - Richmond - Auto AWLS. Wind 16/7. T&G - 19R IAD - wing down term decreased to 30% for rollout - TD centerline - rollout within centerline and 5 ft left.

	At 20'	TD
INS Hdg:	186.0	185.0

Run 2 - Richmond - Auto AWLS. Wind 18/8. T&G - 19R IAD - TD 5 ft right - delayed wheel spin-up and rollout engage..

	At 20'	TD
INS Hdg:	185.5	185.0

Run 3 - Richmond - Auto AWLS. Wind 18/8. T&G - 19R IAD - A/P ROLL fault at decrab - TD centerline. Manual rollout.

Run 4 - Richmond - Auto AWLS. Wind 12/8. T&G - 1R IAD - TD 5 ft left - good rollout, 15 ft left then to centerline - good decrab.

	At 20'	TD
INS Hdg:	008.5	07.1

Run 5 - Janssens - Auto AWLS. Wind 14/8. Full stop - 1R IAD - TD 10 ft left - rollout very close to centerline.

	At 20'	TD
INS Hdg:	008.0	006.5

Run 6 - Janssens - Auto AWLS. Wind 19/8. Full stop - 1R IAD - TD 10 ft left - rollout 30 ft left, good correction to centerline.

Run 7 - Janssens - Auto AWLS. Wind 13/6. Full stop - 1R IAD - TD 10 ft right - rollout 14 ft left - stop 5 ft left - decrab and rollout good. T.O. 19L.

Run 8 - Janssens - Auto AWLS. Wind 15/5. Full stop 13 NAFEC - TD and rollout good, within 10 ft of centerline - wheel spin-up slow.

MISSION NO. 76 DATE: 6 Feb 74 TIME: 2.1 TOTAL: 183.3

1. Mission Objective: Fault Analysis.

2. Mission Profile: Multiple ILS approaches to runway 31, NAFEC.

3. Configuration: INS.

4. Mission Synopsis: Nine AWLS approaches were flown to runway 31, NAFEC to evaluate the system with various faults injected at touchdown.

5. A Summary of the Runs Follows:

NOTE: F.A. - Fault Analysis

Run 1 - Richmond - Auto AWLS. Wind 12/9. T&G - F.A. - Course shift in HSI 3° right at TD - Radar Alt. off on pilot's side - manual decrab and rollout.

Run 2 - Richmond - Auto AWLS. Wind 12/10. T&G - F.A. - HSI Course shift 3° right at TD - TD 15 ft right - rollout 50 ft right - corrected left - 15 ft right at lift off.

Run 3 - Richmond - Auto AWLS. Wind 12/10. T&G - F.A. - HSI Course shift 3° left at TD. TD 15 ft left - rollout 50 ft left - corrected to right rapidly - tripped yaw damper.

Run 4 - Richmond - Auto AWLS. Wind 10/9. T&G - F.A. - Failed #1 LOC receiver at TD - TD and rollout centerline - delayed wheel spin-up.

Run 5 - Richmond - Auto AWLS. Wind 09/7. Intercepted LOC too close in - tracking oscillated - go around.

Run 6 - Richmond - Auto AWLS. Wind 13/5. T&G - F.A. - Failed #1 LOC receiver at TD - TD 10 ft left, rollout 80 ft left, heading only tracking.

Run 7 - Richmond - Auto AWLS. Wind 11/6. T&G - F.A. - failed FDC #1 at TD. TD 10 ft left - rollout 5 ft left, straight.

Run 8 - Richmond - Auto AWLS. Wind 10/7. T&G - F.A. - failed FDC #1 at TD. TD and rollout on centerline.

Run 9 - Richmond - Auto AWLS. Wind 10/4. Full stop - 6 WRI - F.A. - failed INS #2 at TD. TD centerline - rollout 75 ft right - RCI still commanded right - pilot took over visually.

MISSION NO. 77 DATE: 7 Feb 74 TIME: 2.4 TOTAL: 185.7

1. Mission Objective: Check rollout and fault analysis.

2. Mission Profile: Multiple ILS approaches to runway 06 at Bradley INT, Conn.

3. Configuration: INS.

4. Mission Synopsis: Three automatic AWLS approaches were flown to runway 6 at Bradley INT, Conn. The ILS beam was very erratic in both LOC and G/S, resulting in unacceptable tracking for an AWLS approach. The mission was terminated early.

5. A Summary of the Runs Follows:

Run 1 - Lipcsey - Auto AWLS. Wind 02/8. T&G - HSI preset courses differ by 2°. - A/P ROLL at APPR ARM - continued with manual roll control - Manual TD and rollout.

Run 2 - Lipcsey - Auto AWLS. Wind 04/7. T&G - TD 10-15 ft right - rollout maintained 40 ft right aligned with centerline, but did not correct to centerline.

Run 3 - Lipcsey - Auto AWLS. Wind 36/6. T&G - TD 10 ft left - good decrab - rollout to centerline and stayed there.

MISSION NO. 78 DATE: 19 Feb 74 TIME: 1.5 TOTAL: 187.2

1. Mission Objective: Check system after rewiring of CAT III box. Check flare after readjustment of nose-up ramp. (Reduced 20%)

2. Mission Profile: Multiple ILS approaches to runway 6L, Cox-Dayton and runway 23, WPAFB.

3. Configuration: INS.

4. Mission Synopsis: Five AWLS approaches were flown to runway 23, WPAFB and one to runway 6L, Cox-Dayton. The readjusted flare is operating quite well. Some problem existed in the #2 LOC receiver. However, the problem seems to have been corrected during the mission. This will be confirmed on the next mission. High traffic density at Cox-Dayton resulted in early termination of the mission.

5. A Summary of the Runs Follows:

Run 1 - Richmond - MAN AWLS. Wind 25/8. T&G - FFO 23 - LOC flag on copilot's HSI, however, CDI indications good - no auto LOC tracking - A/P ROLL, LOC, DECRAB fault at APPR ARM - manual landing.

Run 2 - Richmond - MAN AWLS. Wind 24/5. FFO 23 - no auto LOC tracking - A/P ROLL, LOC DECRAB at APPR ARM - Go around at 300 ft, A/C on runway.

Run 3 - Richmond - Auto AWLS. Wind 32/8. T&G - FFO 23, swapped LOC receivers - TD 5 ft left - delayed rollout engage - rollout way left, skidding due to crosstrack rate induced at decrab.

Run 4 - Richmond - Auto AWLS. Wind 32/10. T&G - FFO 23 - TD centerline - rollout left - flare good - drift induced at decrab - insufficient wing down at decrab for this crosswind.

Run 5 - Richmond - Split ILS AWLS. Wind 32/10. Day 6L - captured LOC too close in - A/P roll, DECRAB at APPR ARM - continued with manual roll - go-around at 700 ft.

Run 6 - Richmond - Auto AWLS. Wind 32/14. Full stop - FFO 23 - on centerline at decrab - TD center - visual rollout.

MISSION NO. 79 DATE: 20 Feb 74 TIME: 2.3 TOTAL: 189.5

1. Mission Objective: Fault Analysis.

2. Mission Profile: Multiple AWLS approaches at Cox Airport (DAY) and WPAFB.

3. Configuration: INS.

4. Mission Synopsis: On takeoff roll the expanded LOC oscillated +20 micro-amps. This only occurred one time, at WPAFB. One normal AWLS and nine failure analysis (F.A.) approaches were accomplished. On all landings except the full stop, the aircraft stayed within 35 ft of the centerline. It was decided that the best procedure for fault warning was for the jump-seat occupant to call "Go-around" for any System #2 fault, and "Manual one, go-around" for any System #1 fault. For a #1 fault, the pilot would first select ADI REPEAT, and then go-around. It was also decided that the pilot would check the course select window for the correct course at 1000 ft AGL, and the expanded localizer position at 100 ft. Because of the difficulty in making a full stop from the high speed of a touch-and-go, it was decided that a go-around for an engine failure during a touch-and-go would be safer than an abort.

5. Approach Summaries:

Run 1 - Johns; DAY - Auto AWLS. Wind calm. Touchdown on centerline.

Run 2 - Johns; DAY - Auto AWLS. Wind V/1-2. F.A. - Loc Rec #1 failure at TD. Pilot did not use ADI REPEAT (Had heading info only) - drifted left 35 ft - on the ground about 1500 ft. T&G.

Run 3 - Johns; DAY - Auto AWLS. Wind calm. F.A. - Loc Rec #1 failure at TD. Pilot used ADI REPEAT, but still went 35 ft left. T&G.

Run 4 - Johns; DAY - Auto AWLS. F.A. - Loc Rec #2 failure at TD. Got MANUAL CAUTION, SPARE, DECRAB fault lights. TD 10 ft left - rolled to 20 ft left, then converged to center. T&G.

Run 5 - Johns; DAY - Auto AWLS. F.A. - FDC #1 failure at TD. G/S progress light went out, FLT DIR 1 fault light came on - no MANUAL CAUTION light. Pilot went to ADI REPEAT and corrected nicely to centerline. T&G.

Run 6 - Johns; DAY - Man AWLS. F.A. FLT DIR #2 failure on G/S. LOC and G/S progress lights went out - MANUAL CAUTION, TPLC fault lights. Continued manual approach. Checked course set at 300 ft - caused some confusion. Checked expanded loc at 40 ft - go-around was at angle to runway.

Run 7 - Johns; DAY - Auto AWLS. F.A. - FLT DIR #1 failure at TD. FLT DIR 1 fault light - No MANUAL CAUTION light - G/S progress light went out - G/S flag in view - rollout (ADI REPEAT) within 10 ft of centerline. T&G.

Run 8 - Johns; DAY - Auto AWLS. F.A. - rollout spin-up box disconnected. No rollout light - waited 3 secs and then went around. TD 10 ft left - Went to 30 ft left and then paralleled. T&G.

Run 9 - Johns; DAY - Auto AWLS. F.A. - Changed course set by 5 degrees (right) at TD. Aircraft made sharp turn to right. Pilot had to stop aircraft visually at right edge of runway. T&G. (TD 10 ft left).

Run 10 - Johns; FFO - Auto AWLS. Wind 14/02. F.A. - Engine failure at rotate speed on T&G. (On the approach, #2 G/S flag did not pull - G/S progress light did not light - Autopilot still flew G/S.) Engine failure at 8,000 ft remaining - Call of "Reject" not immediately reacted to - aircraft went slightly airborne when spoilers deployed. Full stop.

APPENDIX B

Baseline Tracking Data

The data obtained at NAFEC from 12 Sep 73 through 21 Sep 73 is as follows:

AUTOMATIC APPROACHES:	69
MANUAL APPROACHES:	30
TOTAL APPROACHES:	99

The manual approaches were not included as baseline data due to glideslope receiver malfunctions. Only 12 out of the 30 manual approaches resulted in touchdowns. The automatic approaches may be further broken down as follows:

BASELINE APPROACHES:	49
ABORTED APPROACHES:	3
INSUFFICIENT DATA:	17

The baseline and aborted approaches for which data exists are displayed in graphic form in this appendix. The theodolite tracking data is presented on the top half of the page, while the on-board instrumentation (ADDAS) data is presented on the lower half. In order to convert the instrumentation data from micro-amperes from beam center (both localizer and glideslope) to feet from beam center, several steps were required. The instrumentation (ADDAS) data was correlated to the tracking data by time. Since the number of feet per micro-amperes can easily be calculated for a given distance from the beam apex, all that is needed to calculate position from the beam in feet is the distance from the apex (theodolite data) and the micro-amps error (ADDAS data).

Because of the small angle of the beam width, a large error in the distance from the focal point causes a relatively small error in lateral placement calculations. For a 15 micro-amp tracking error, a longitudinal position estimate that is 1000 ft in error results in a cross track position error of 3.2 ft. Since the ADDAS data is referenced to the aircraft nose, and the tracking data is referenced to the main landing gear, a small error was induced by ignoring

the distance between the nose and gear. This error was ignored since the data was rounded off to the nearest foot anyway. A larger difference between theodolite and ADDAS data was probably caused by aircraft heading (crab). Due to instrumentation malfunctions, however, the aircraft heading is not available.

The Category III ILS (Runway 13) at NAFEC has the following constant parameters:

Localizer

Antenna Focal Point to Threshold	11,116 ft
Beam Width (700 ft wide at Threshold)	3.6 deg ($\pm$150 μA)
Displacement at Threshold	2.32 ft/ μA 0.012 Deg/ μA

Glideslope

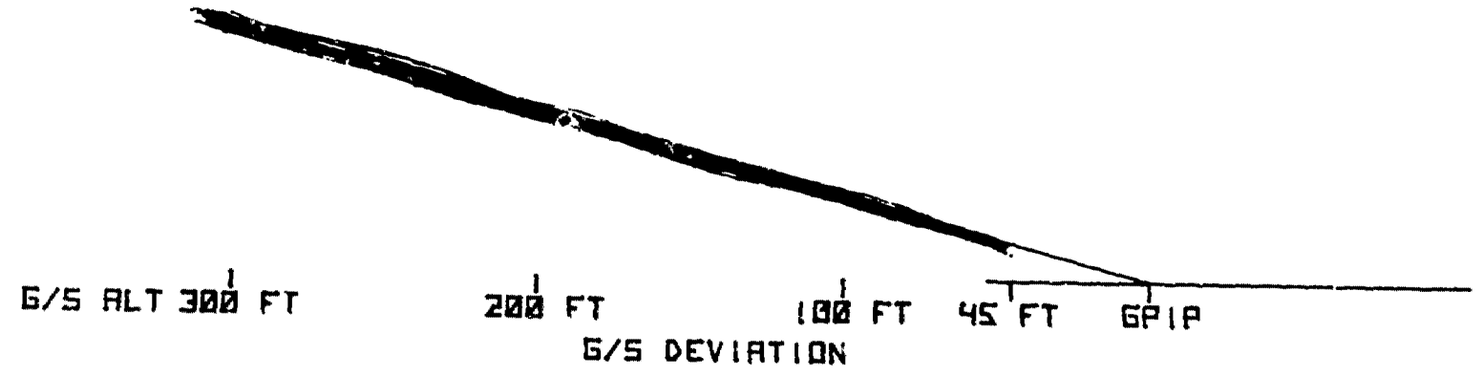
Glide path intercept point (GPIP) (from threshold)	1037.7 ft
Beam Width	1.4 deg ($\pm$150 μA)
Glideslope angle	3.0 deg

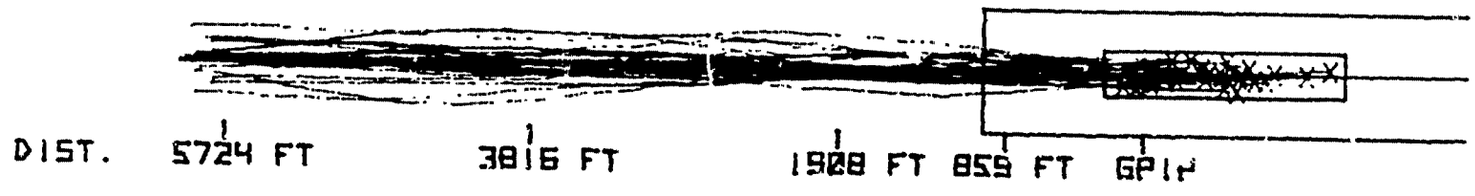
The GPIP for runway 31 is 949 ft from the threshold, and 8.1 ft lower than the GPIP for Runway 13. The tracking data was computed with respect to these GPIP's and runway centerline.

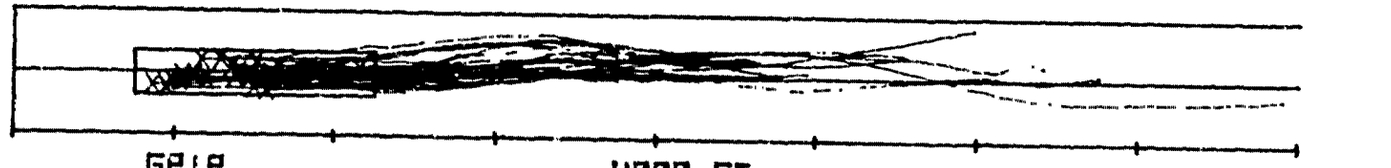
The theodolites tracked the outside rear tire on the left main gear. The data was corrected to aircraft centerline by subtracting ten feet. The data was not corrected to glideslope antenna height because the accuracy required of the data did not warrant the additional effort.

300, 200 and 100 feet AGL were chosen for position printouts for ease in data handling only. 45 feet is the aircraft flare point. The touchdown box depicted is +27 feet from centerline and 1500 feet long. Note that glideslope tracking was often more than 12 feet in error, but that it always corrected back to centerline in a short distance. The looseness of the glideslope tracking might have presented a problem for an aircraft with a high approach speed, but did not seem to degrade the C-141 performance.

The statistics of the approaches and landings are presented in Table 1. The touchdown footprint was considerably better on Runway 13 (CAT III ILS) than on Runway 31 (CAT II ILS), as can be seen in the composite Figures B-1 through B-4. B-1 and B-2 are ADDAS data, while B-3 and B-4 are theodolite tracking data.

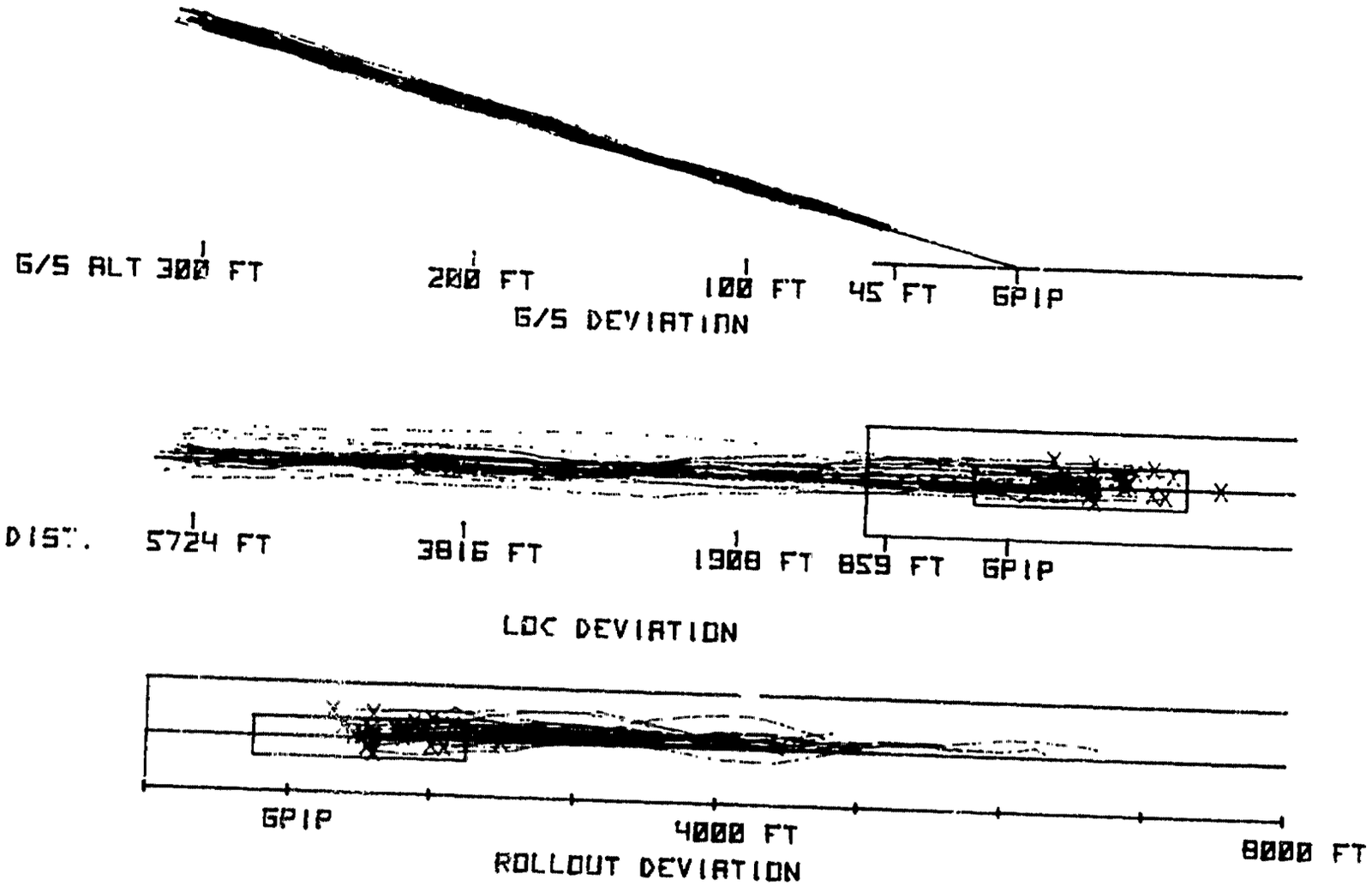






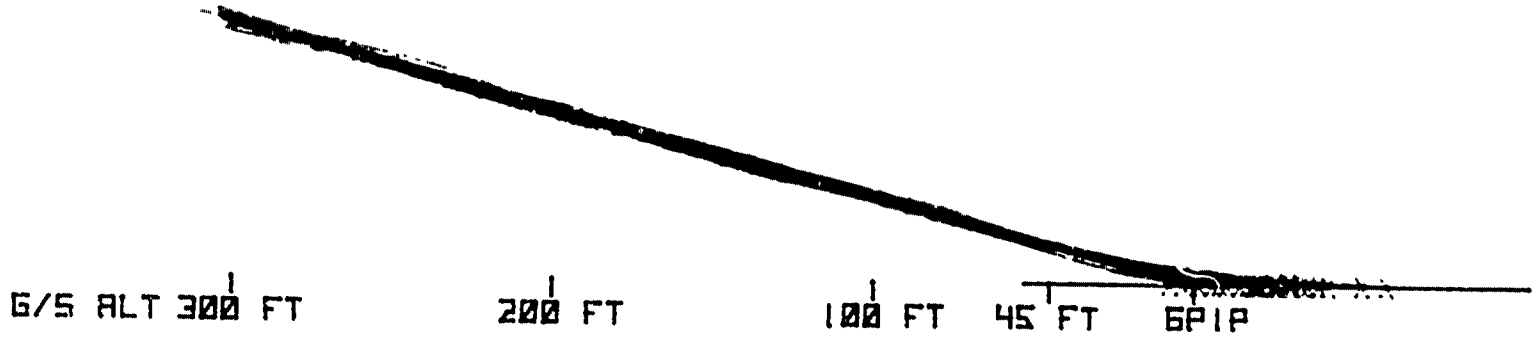
RUNWAY 13 ADDAS DATA

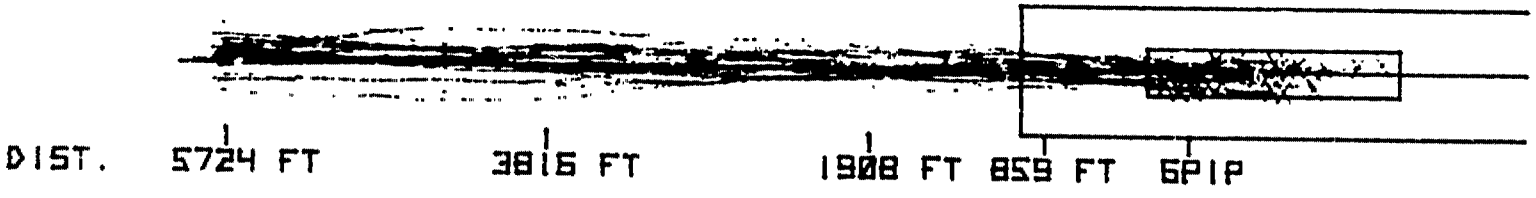
Figure B-1

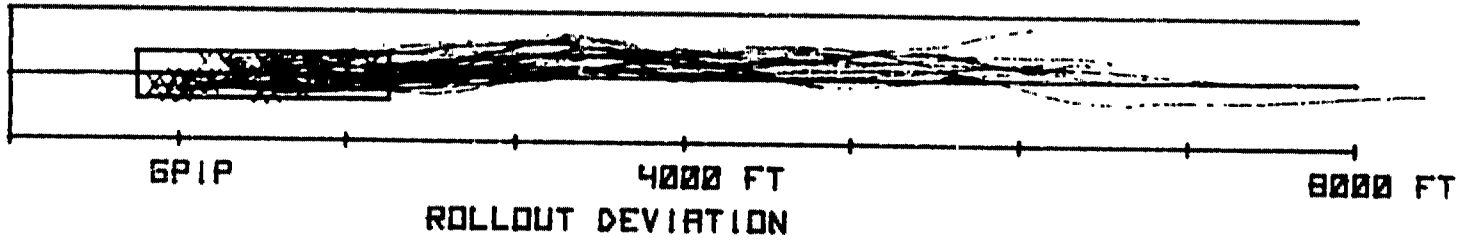


RUNWAY 31 ADDAS DATA

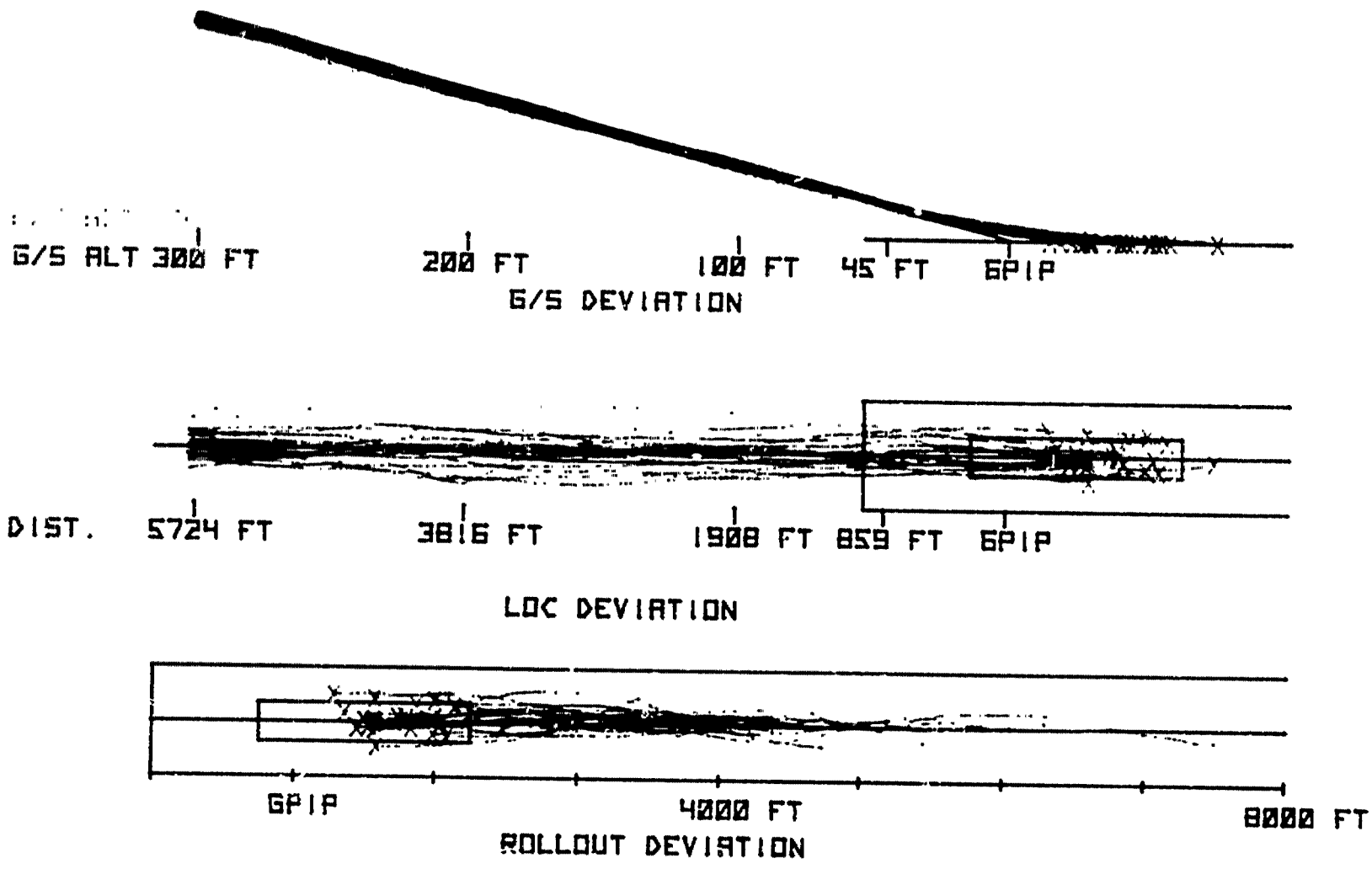
Figure B-2







RUNWAY 13 TRACKING DATA
Figure B-3

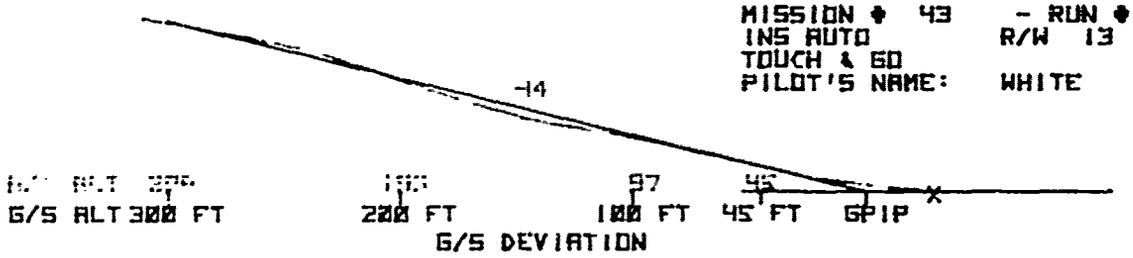


RUNWAY 31 TRACKING DATA

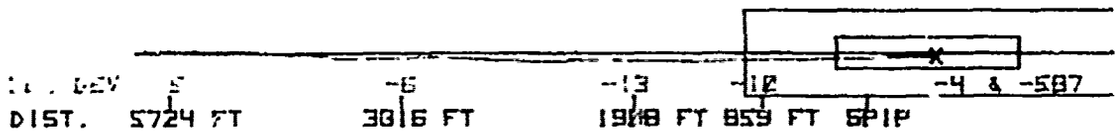
Figure B-4

THEODOLITE TRACKING DATA

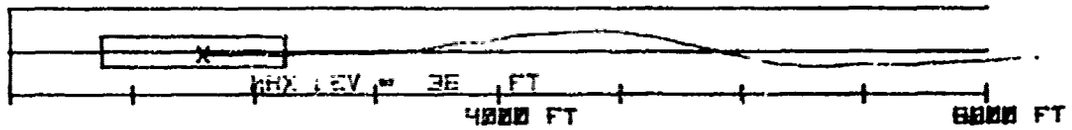
MISSION # 43 - RUN # 1
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

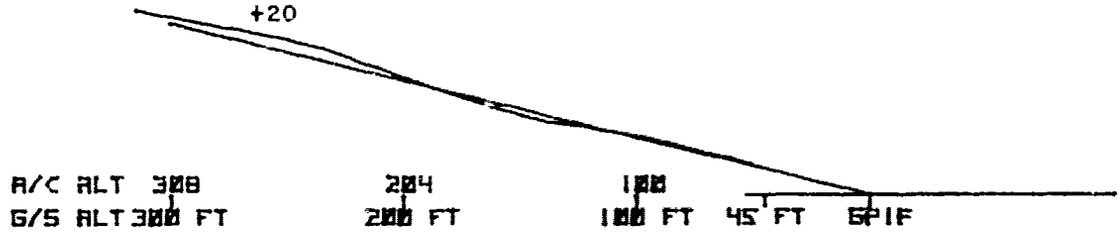


LOC DEVIATION

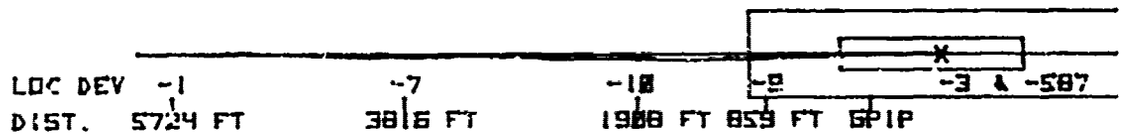


ROLLOUT DEVIATION

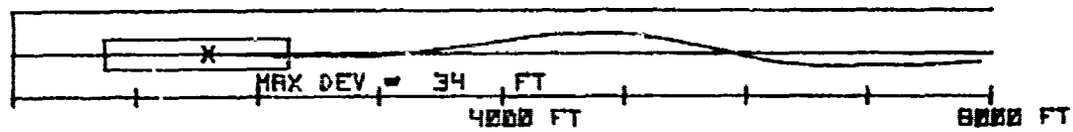
A/C INSTRUMENTATION DATA



G/S DEVIATION



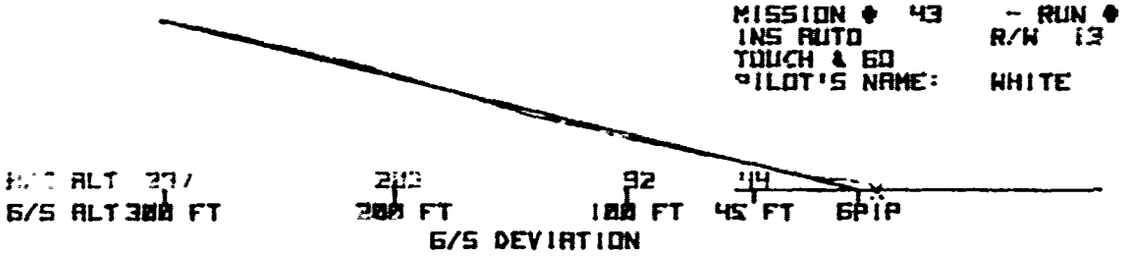
LOC DEVIATION



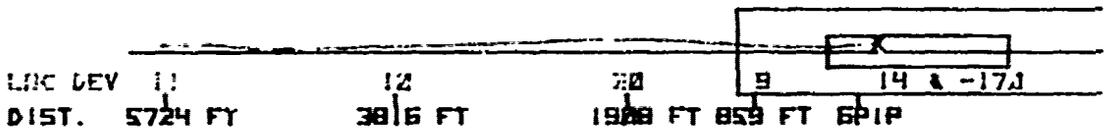
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

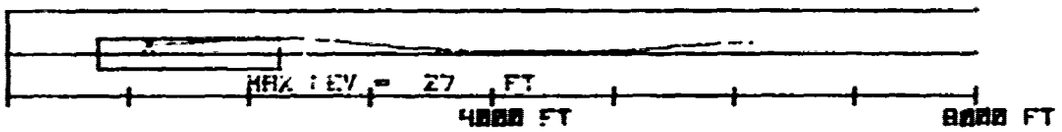
MISSION # 43 - RUN # 4
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

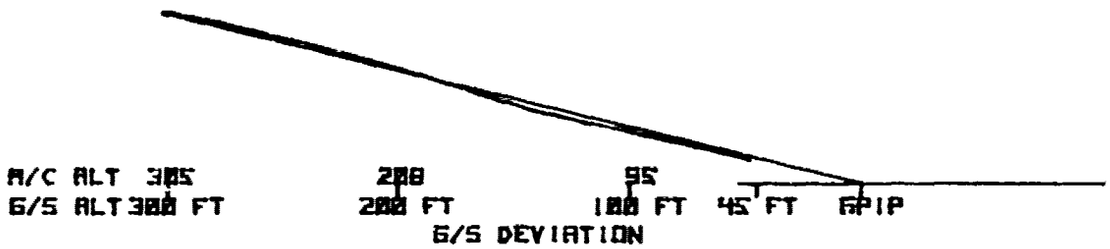


LOC DEVIATION

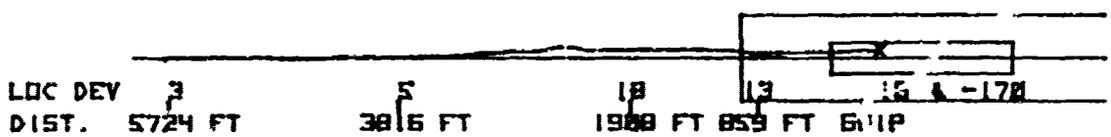


ROLLOUT DEVIATION

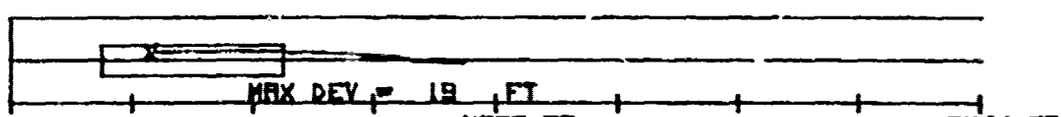
A/C INSTRUMENTATION DATA



G/S DEVIATION



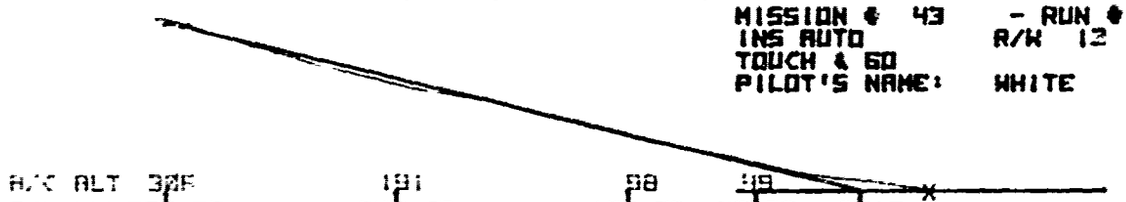
LOC DEVIATION



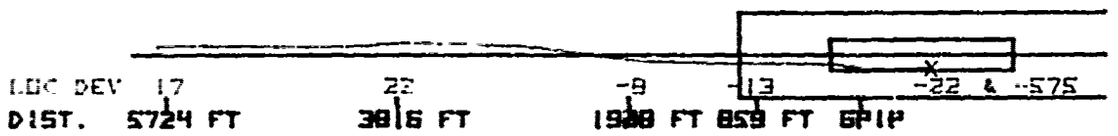
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

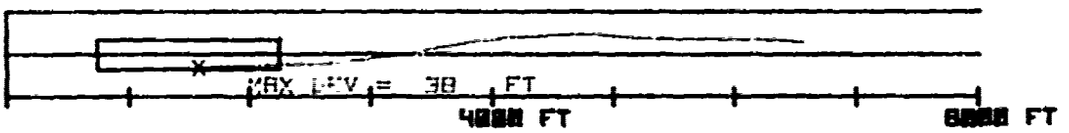
MISSION # 43 - RUN # 5
INS AUTO R/W 12
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

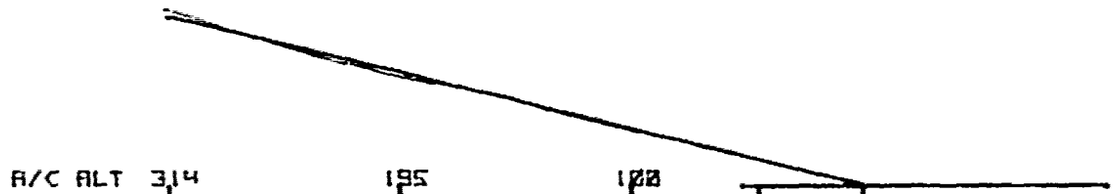


LOC DEVIATION



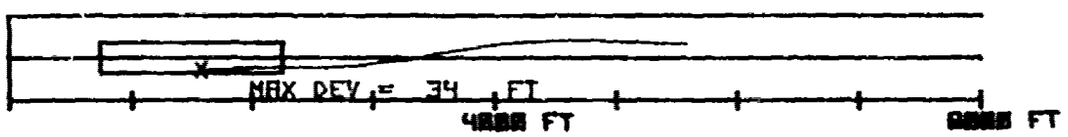
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA



G/S DEVIATION

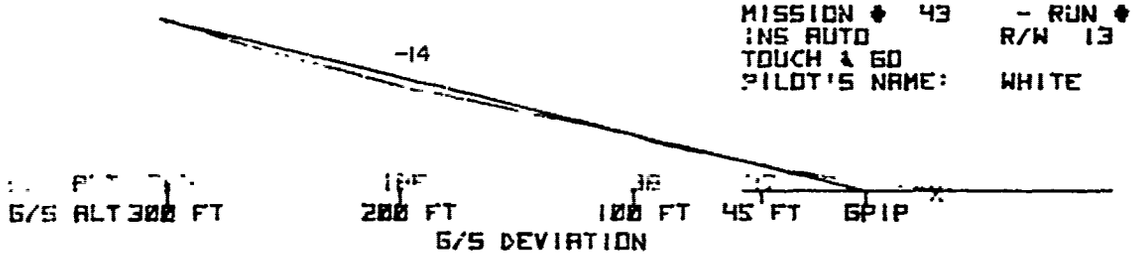
LOC DEVIATION



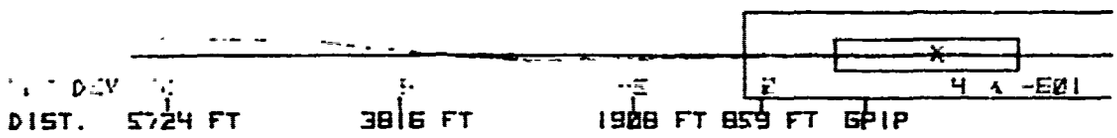
ROLLOUT DEVIATION

TWILIGHT TRACKING DATA

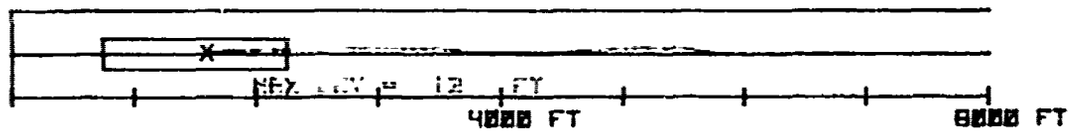
MISSION # 43 - RUN # 7
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

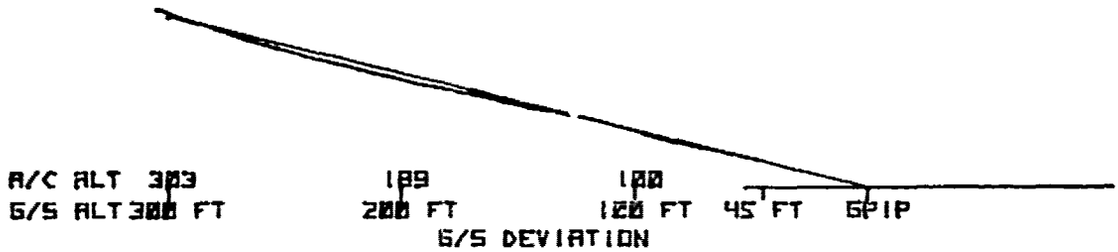


LOC DEVIATION



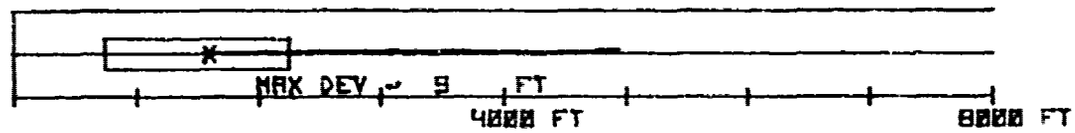
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA



G/S DEVIATION

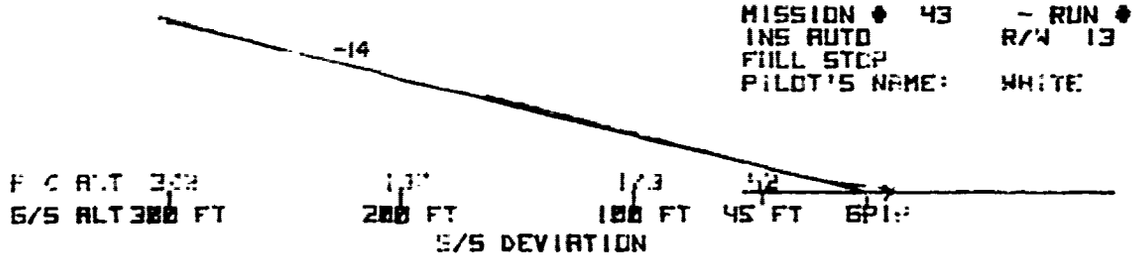
LOC DEVIATION



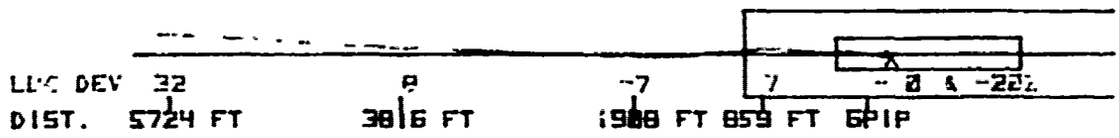
ROLLOUT DEVIATION

TIP, DOLITE TRACKING DATA

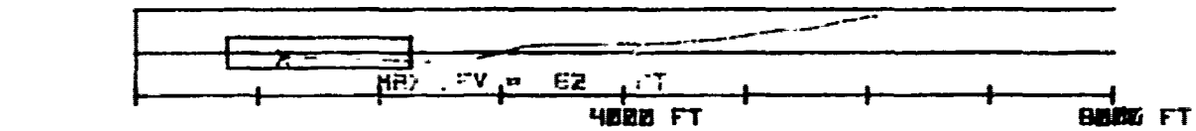
MISSION # 43 - RUN # 9
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: WHITE



G/S DEVIATION

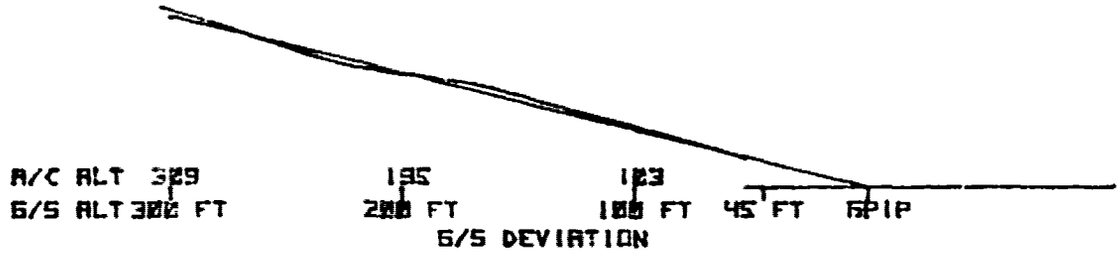


LOC DEVIATION

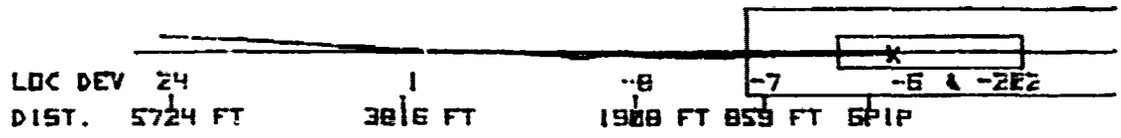


ROLLOUT DEVIATION

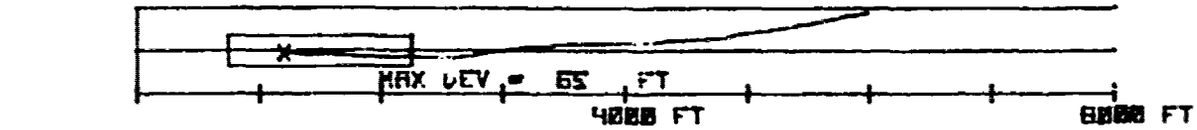
R/C INSTRUMENTATION DATA



G/S DEVIATION



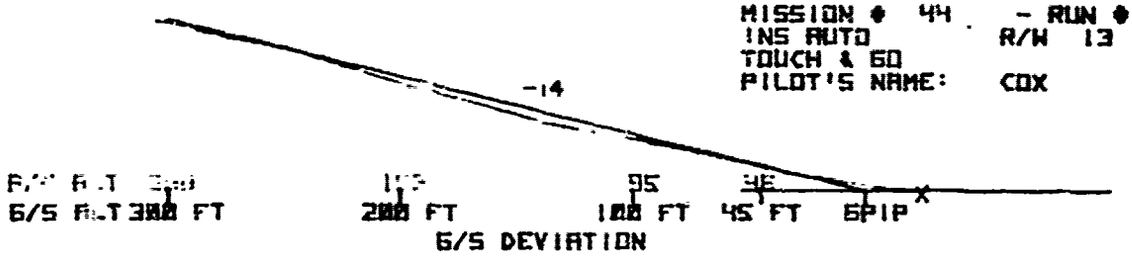
LOC DEVIATION



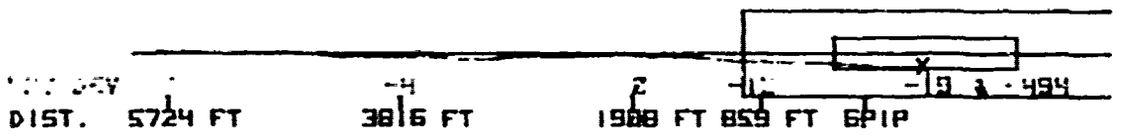
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

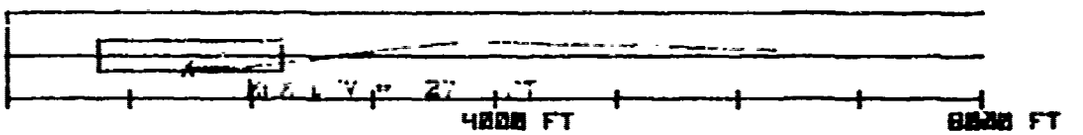
MISSION # 44 - RUN # 1
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: COX



G/S DEVIATION

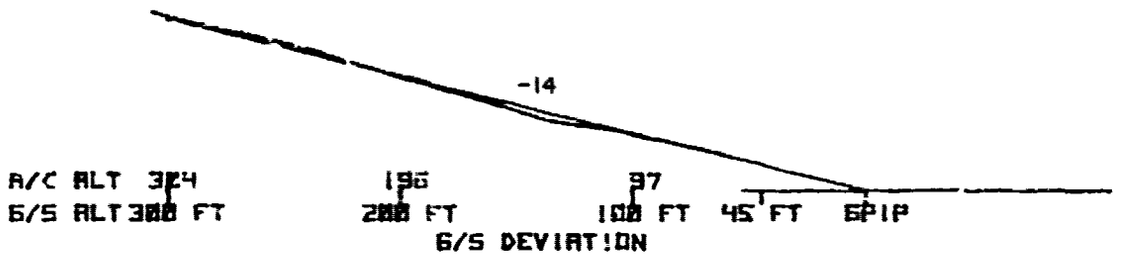


LOC DEVIATION

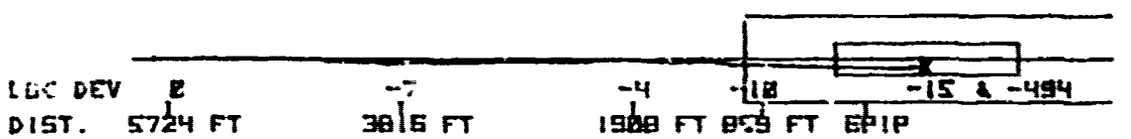


ROLLOUT DEVIATION

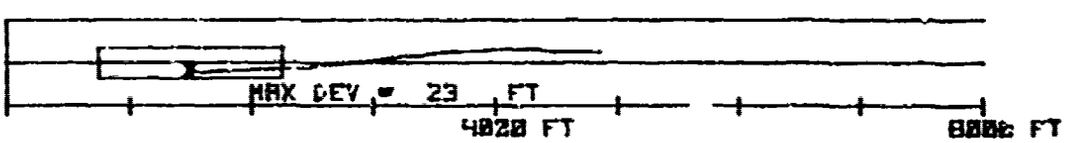
A/C INSTRUMENTATION DATA



G/S DEVIATION



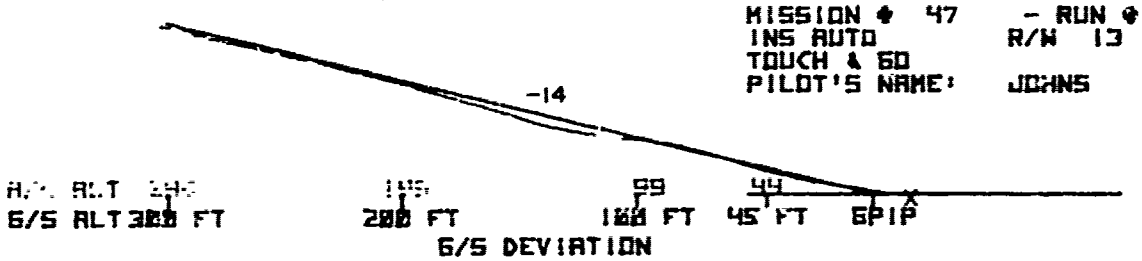
LOC DEVIATION



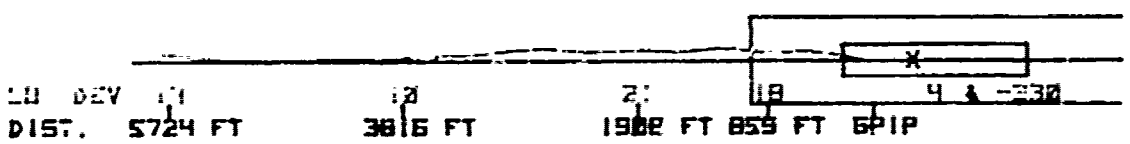
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

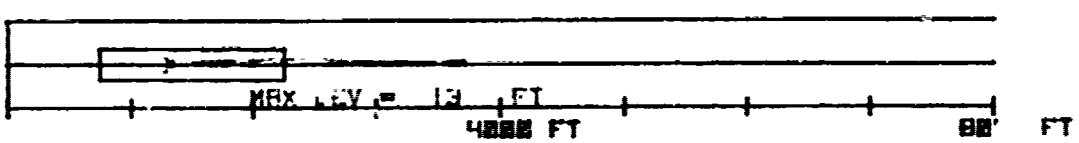
MISSION # 47 - RUN # 1
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: JOHNS



G/S DEVIATION



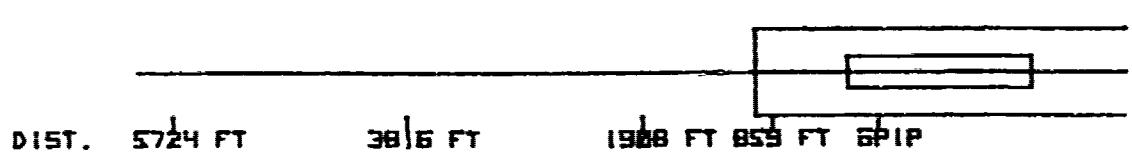
LOC DEVIATION



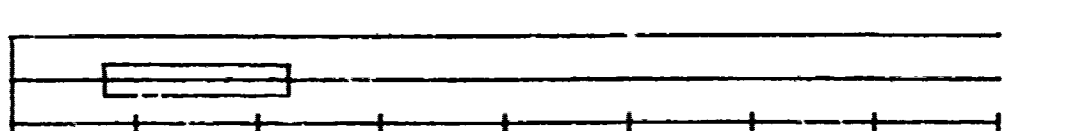
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

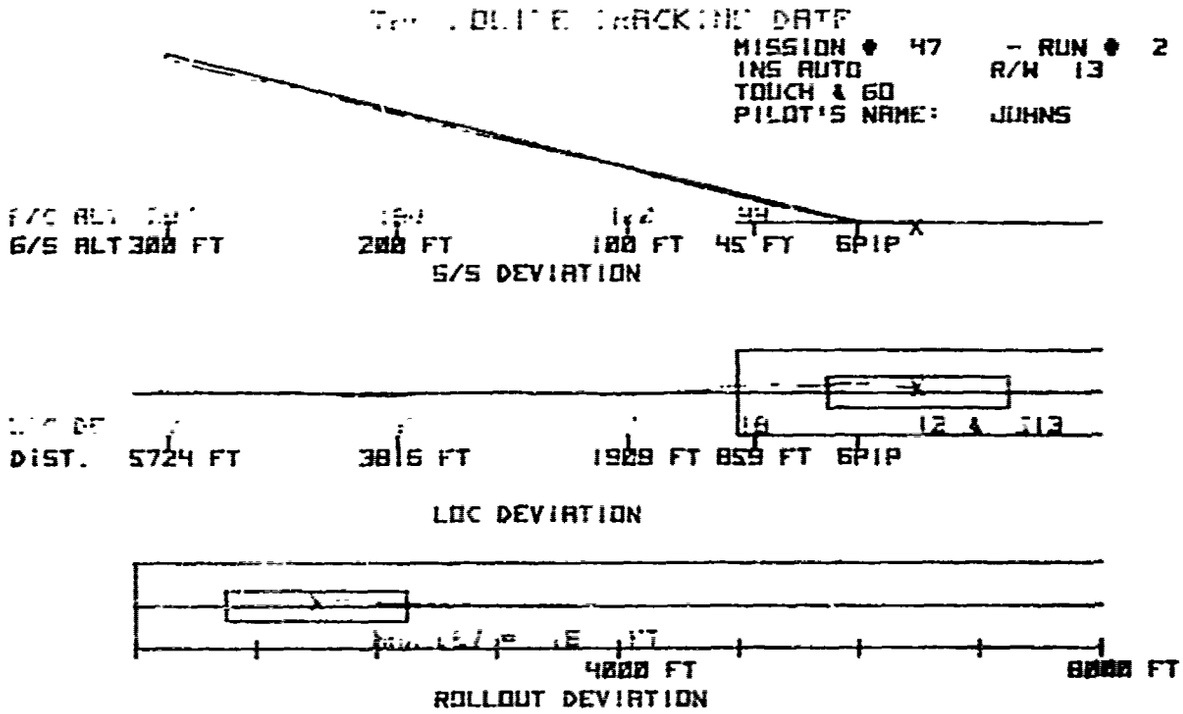
G/S DEVIATION

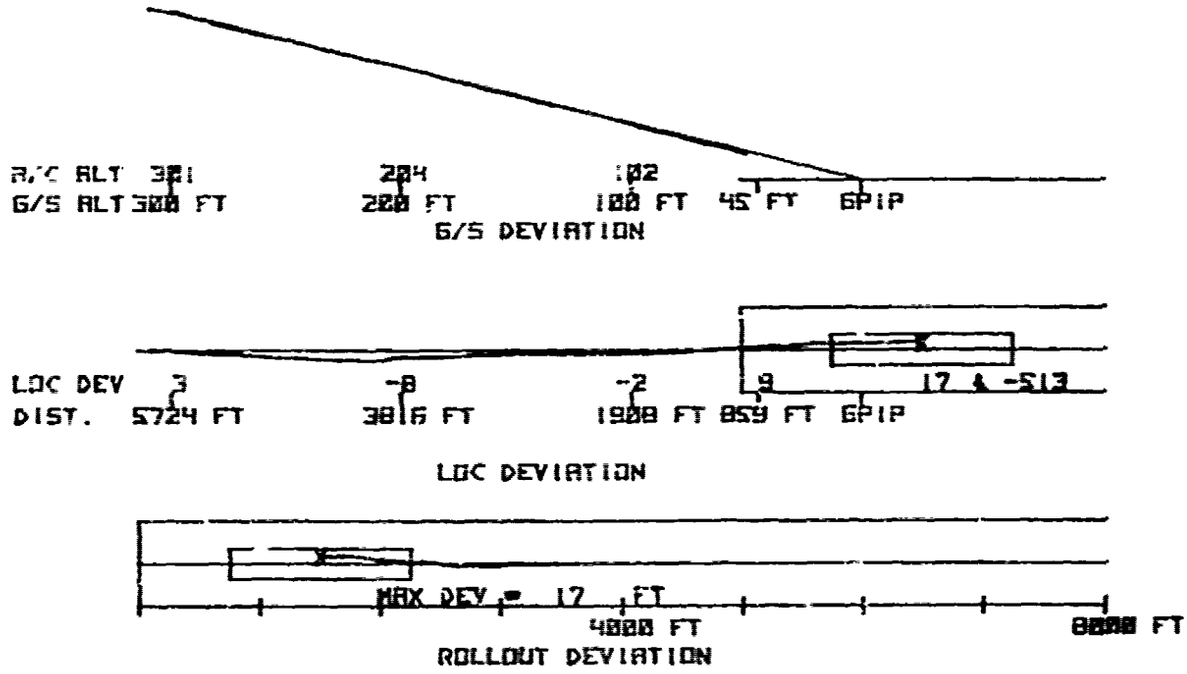


LOC DEVIATION



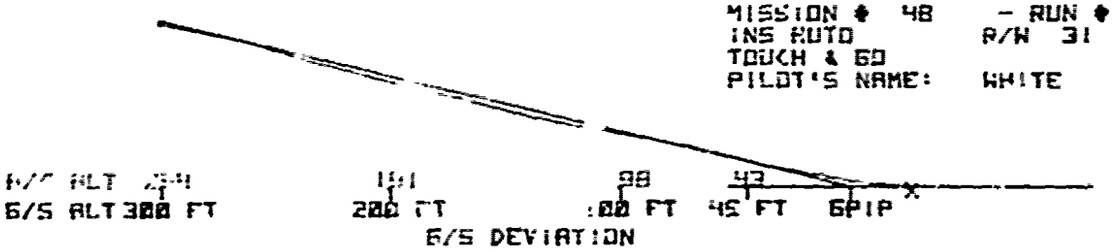
ROLLOUT DEVIATION


MISSION # 47 - RUN # 2
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: JOHNS
G/S ALT 300 FT
200 FT
100 FT
45 FT
6PIP
G/S DEVIATION
DIST. 5724 FT
3816 FT
1908 FT
859 FT
6PIP
LOC DEVIATION
4000 FT
8000 FT
ROLLOUT DEVIATION

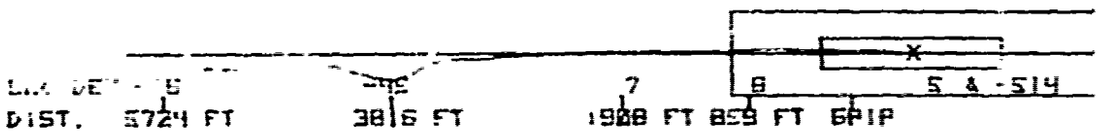

A/C INSTRUMENTATION DATA
G/S ALT 300 FT
200 FT
100 FT
45 FT
6PIP
G/S DEVIATION
LOC DEV
DIST. 5724 FT
3816 FT
1908 FT
859 FT
6PIP
LOC DEVIATION
MAX DEV = 17 FT
4000 FT
8000 FT
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

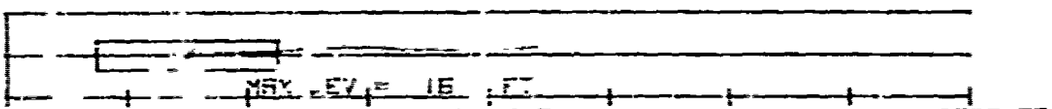
MISSION # 48 - RUN # 1
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

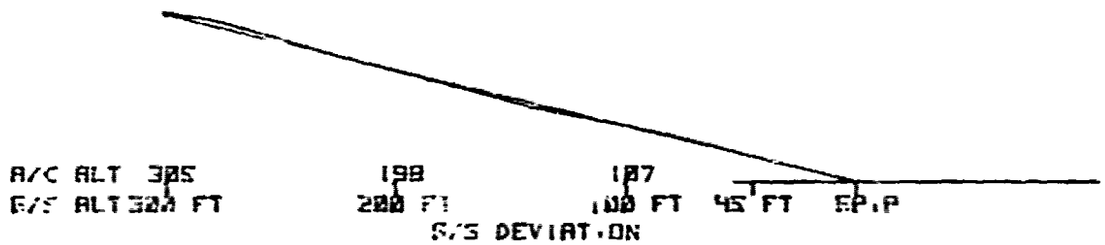


LOC DEVIATION

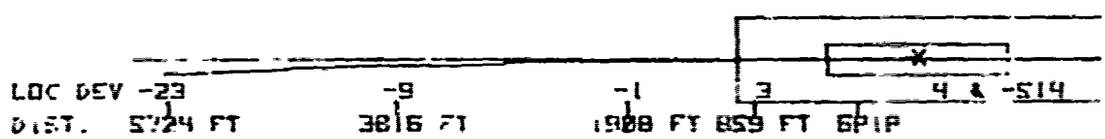


ROLLOUT DEVIATION

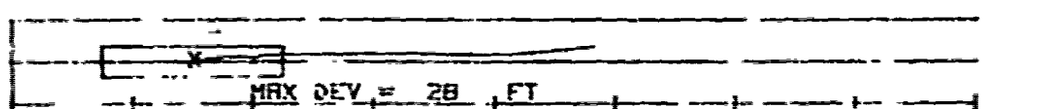
A/C INSTRUMENTATION DATA



G/S DEVIATION



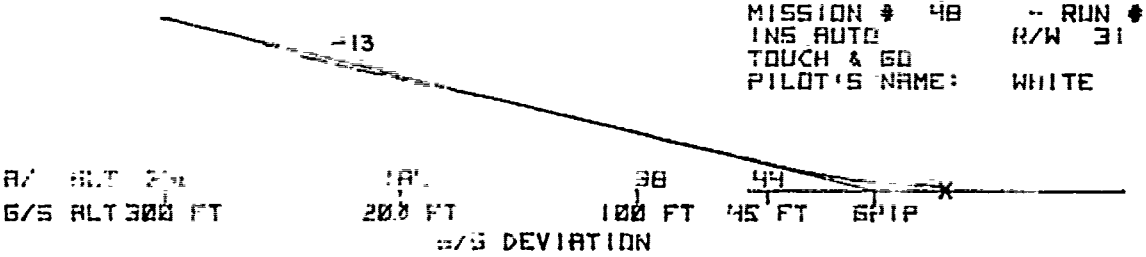
LOC DEVIATION



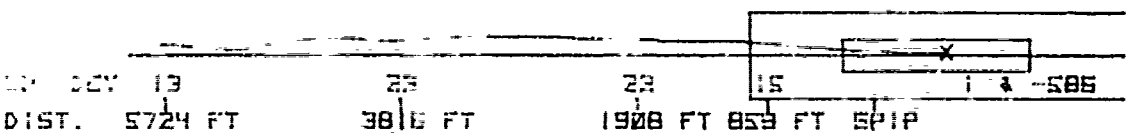
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

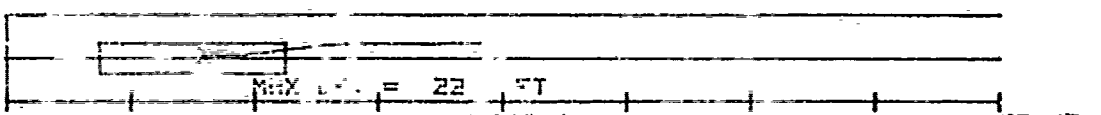
MISSION # 48 — RUN # 3
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

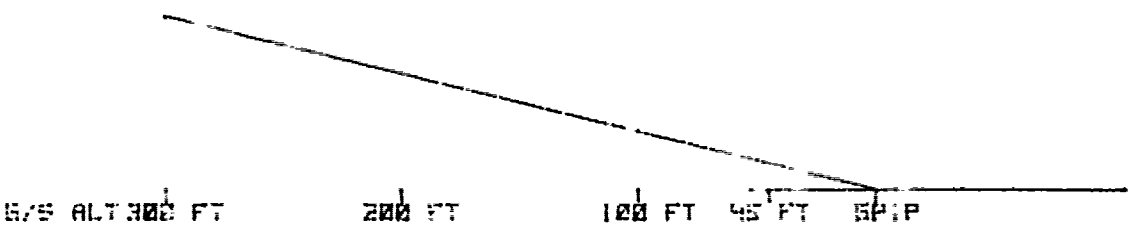


LOC DEVIATION

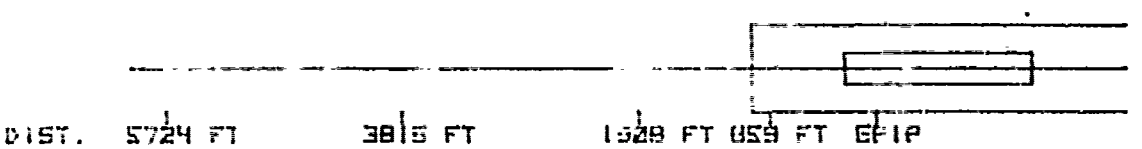


ROLLOUT DEVIATION

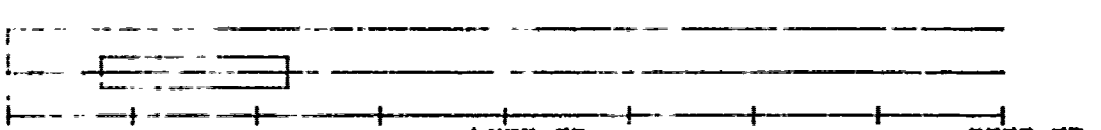
A/C INSTRUMENTATION DATA



G/S DEVIATION



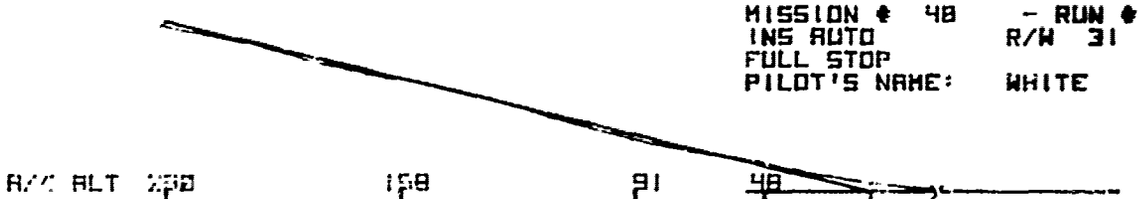
LOC DEVIATION



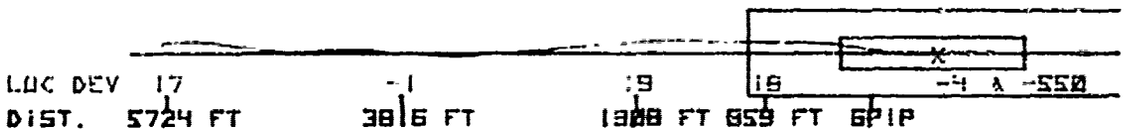
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

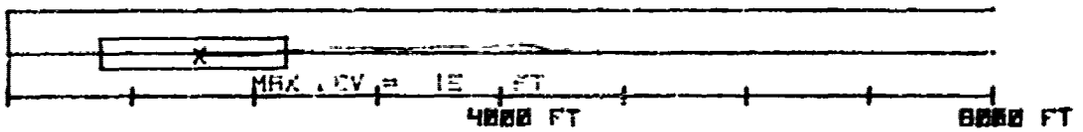
MISSION # 48 - RUN # 4
INS AUTO R/W 31
FULL STOP
PILOT'S NAME: WHITE



G/S DEVIATION

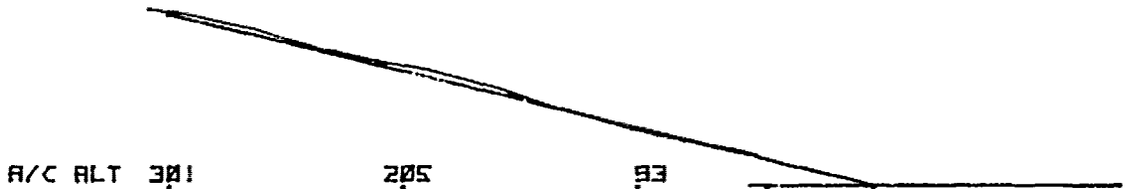


LOC DEVIATION

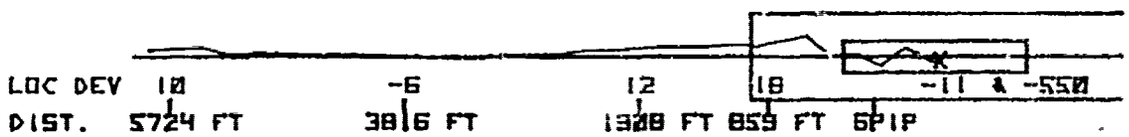


ROLLOUT DEVIATION

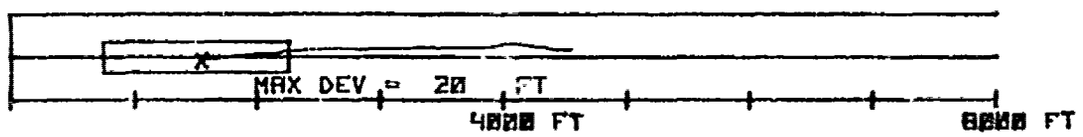
A/C INSTRUMENTATION DATA



G/S DEVIATION

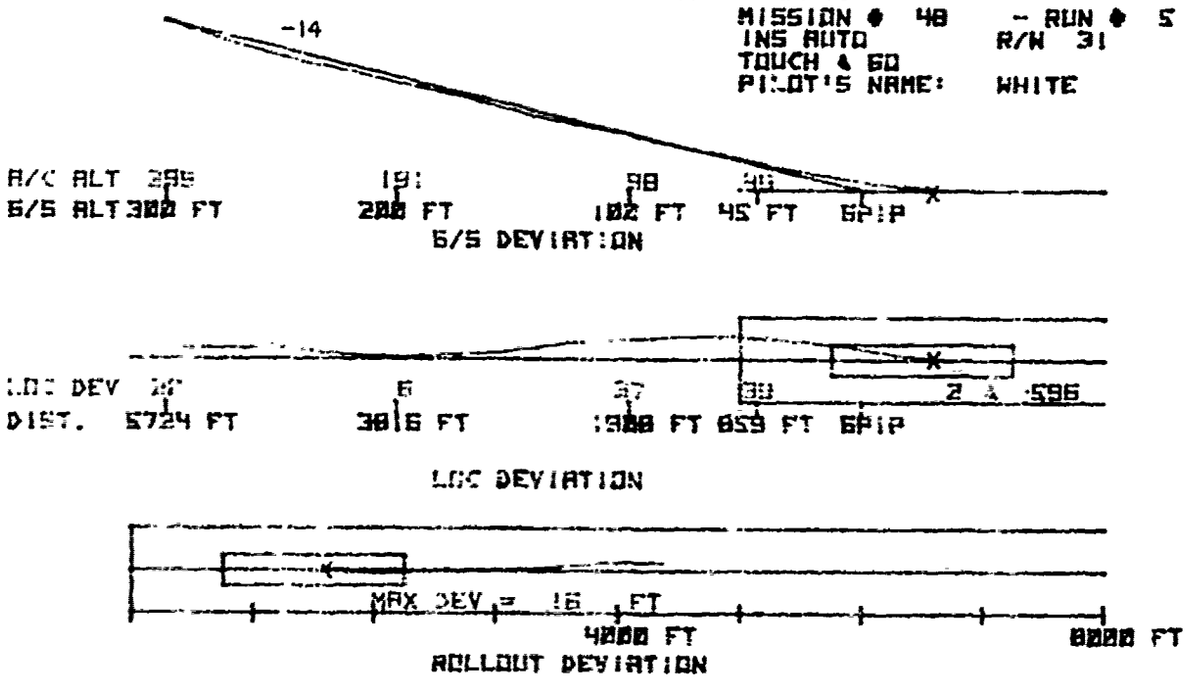


LOC DEVIATION

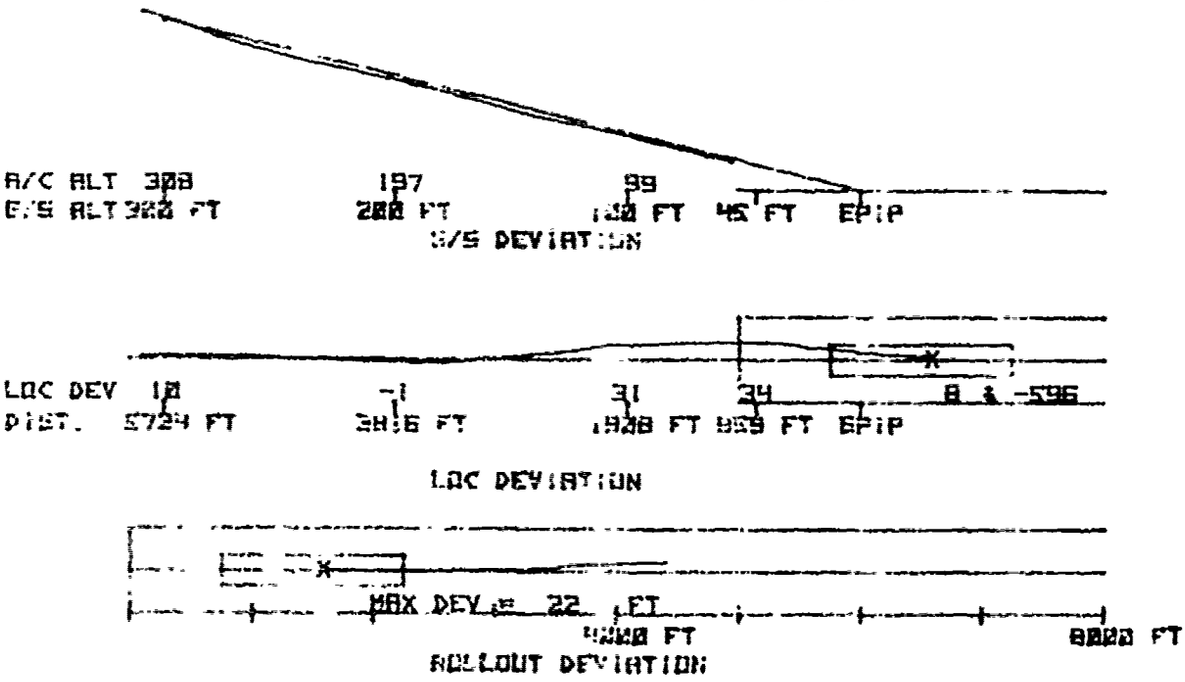


ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

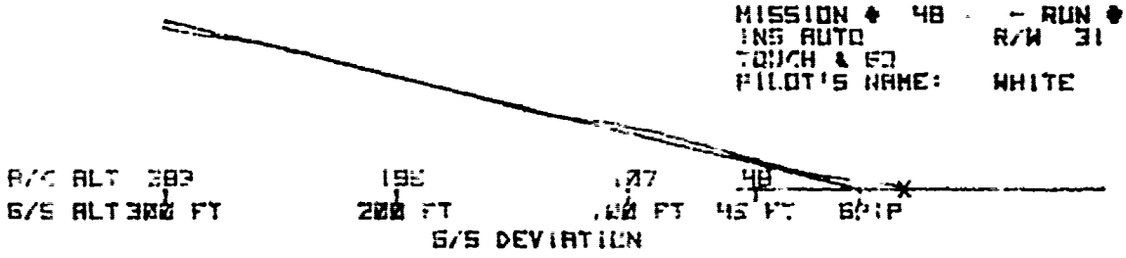


A/C INSTRUMENTATION DATA

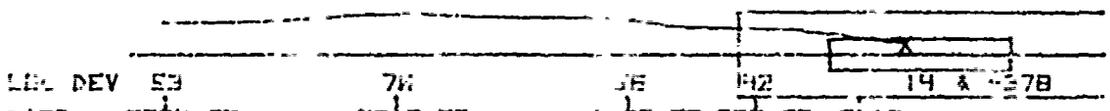


THEODOLITE TRACKING DATA

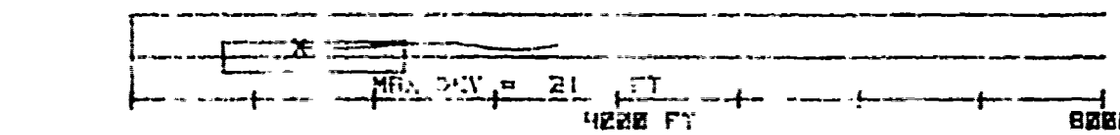
MISSION # 48 - RUN # 7
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

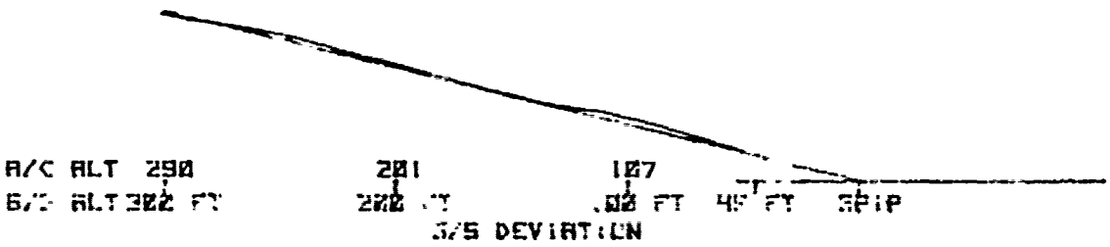


LOC DEVIATION

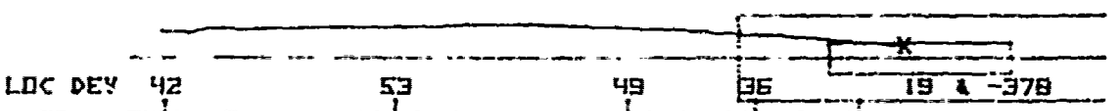


ROLLOUT DEVIATION

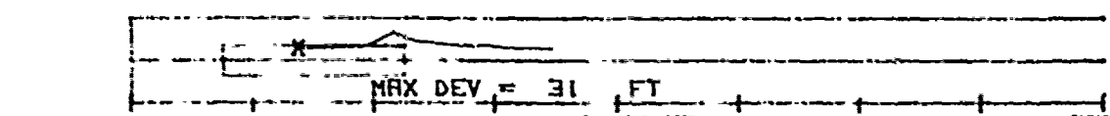
R/C INSTRUMENTATION DATA



G/S DEVIATION



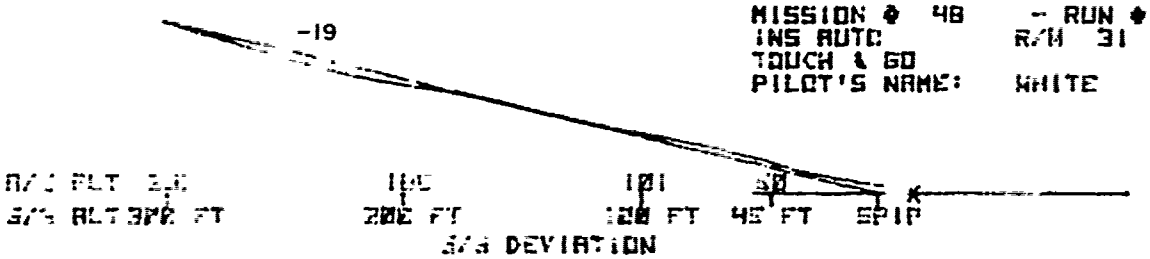
LOC DEVIATION

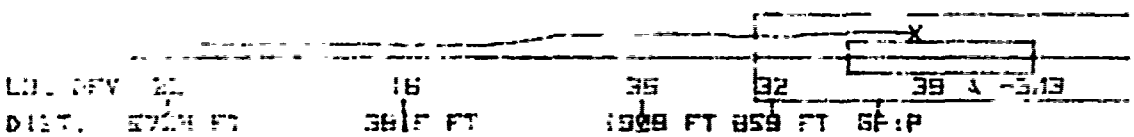


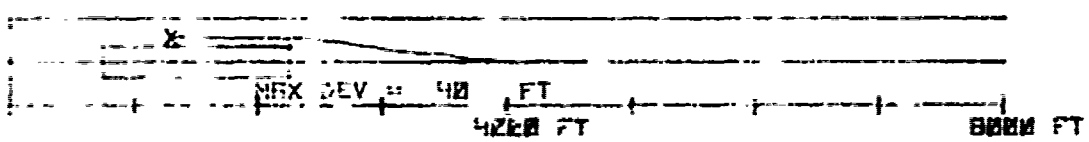
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

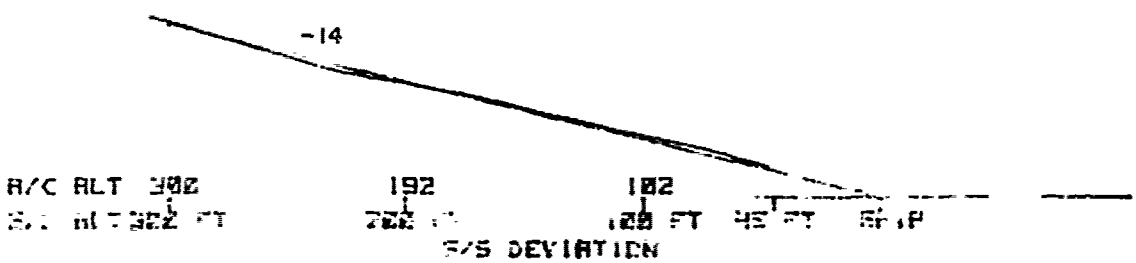
MISSION # 48 - RUN # 8
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: WHITE

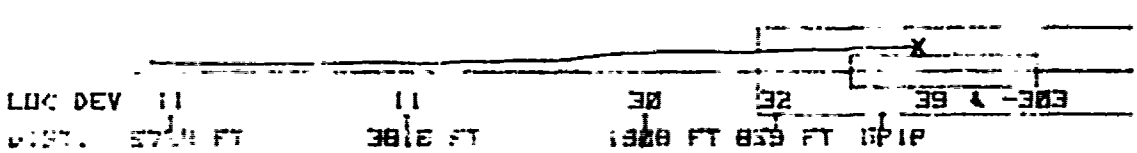


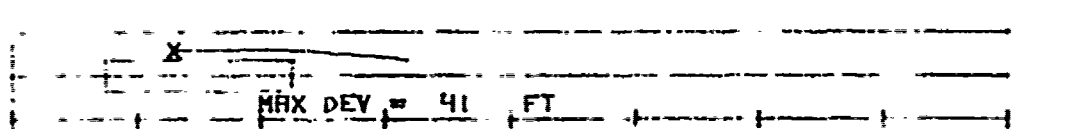




R/C INSTRUMENTATION DATA

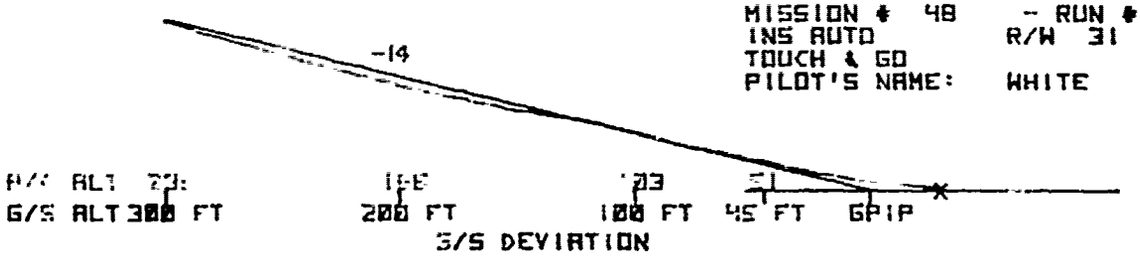




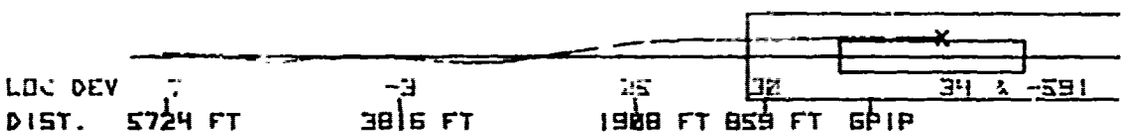


THEODOLITE TRACKING DATA

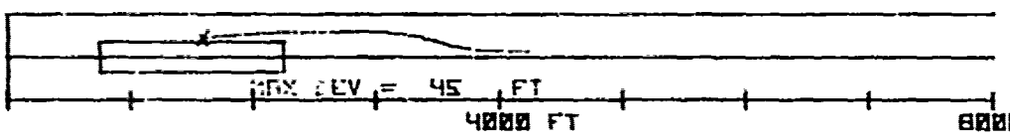
MISSION # 48 - RUN # 11
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: WHITE



G/S DEVIATION

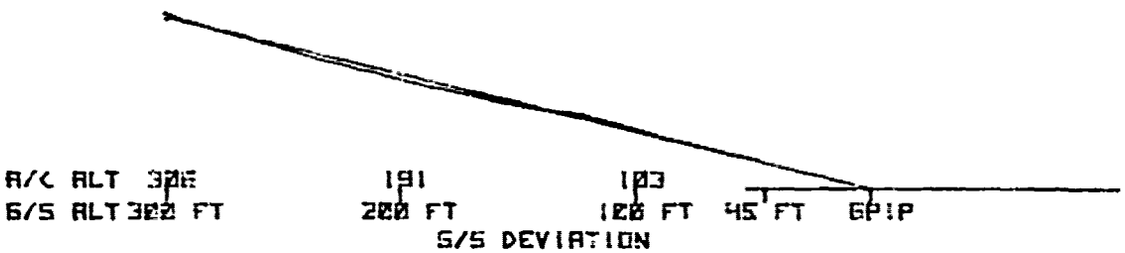


LOC DEVIATION

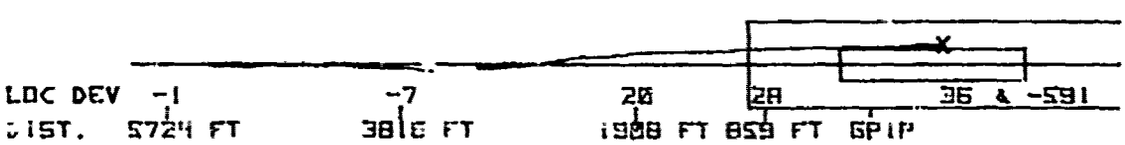


ROLLOUT DEVIATION

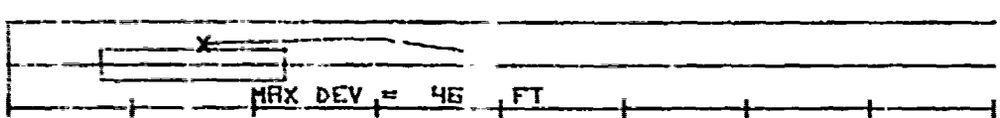
A/C INSTRUMENTATION DATA



G/S DEVIATION



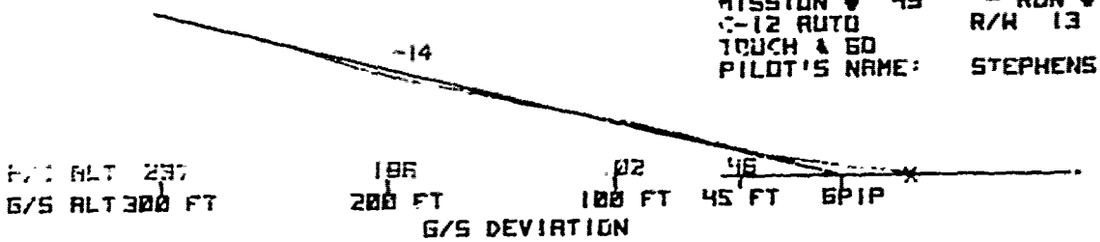
LOC DEVIATION



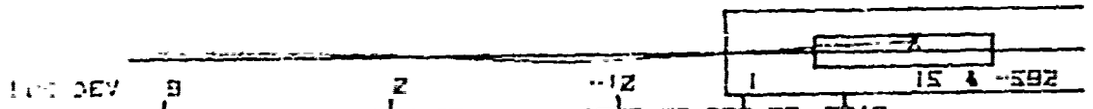
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

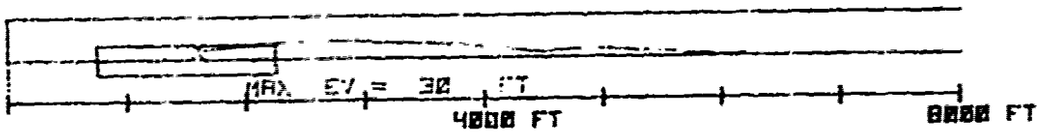
MISSION # 49 - RUN # 1
C-12 AUTO R/W 13
TOUCH & GO
PILOT'S NAME: STEPHENS



G/S DEVIATION

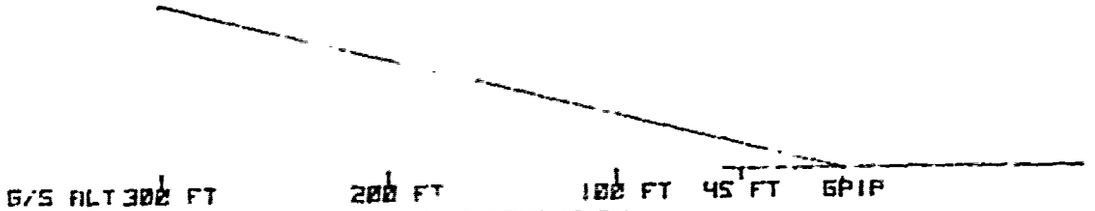


LOC DEVIATION



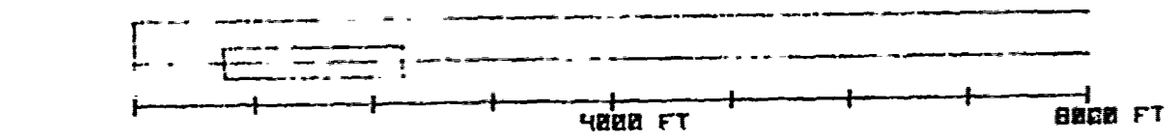
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA



G/S DEVIATION

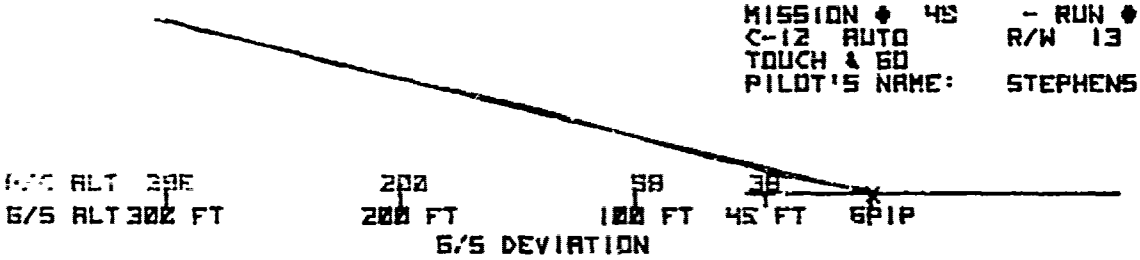
LOC DEVIATION



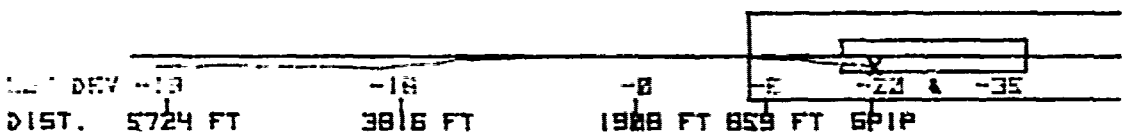
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

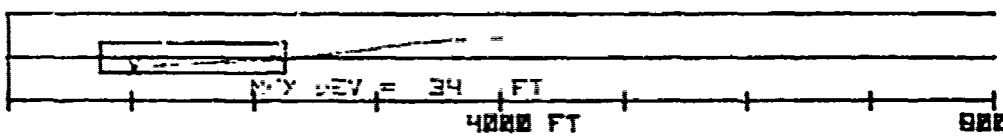
MISSION # 45 - RUN # 4
C-12 AUTO R/W 13
TOUCH & GO
PILOT'S NAME: STEPHENS



G/S DEVIATION

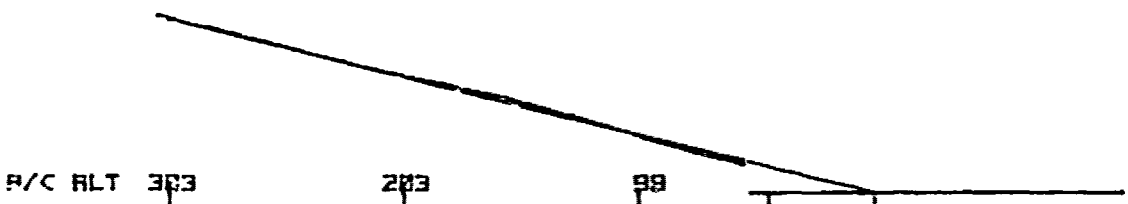


LOC DEVIATION

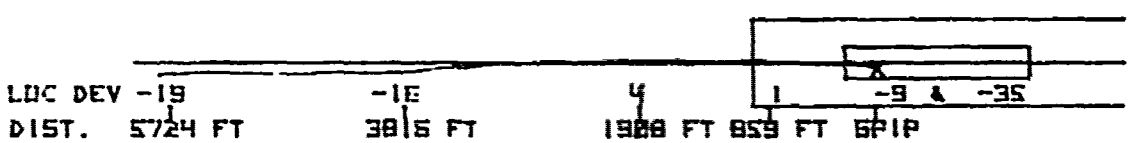


ROLLOUT DEVIATION

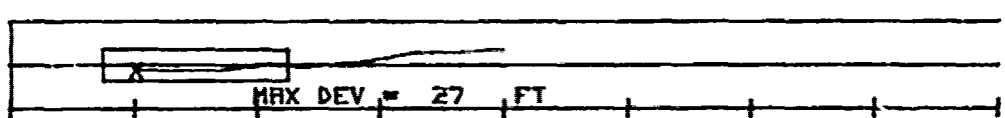
A/C INSTRUMENTATION DATA



G/S DEVIATION



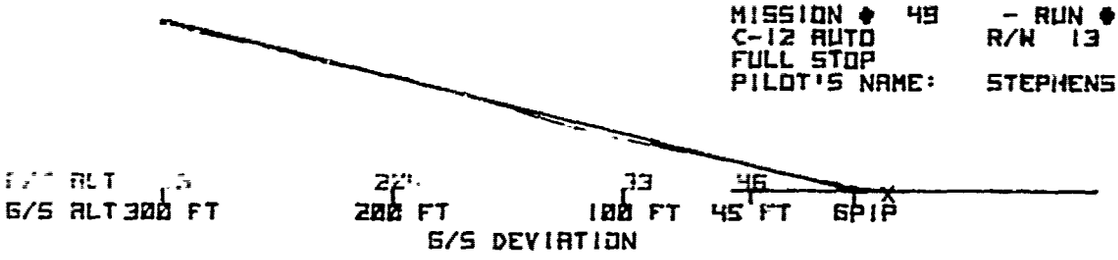
LOC DEVIATION



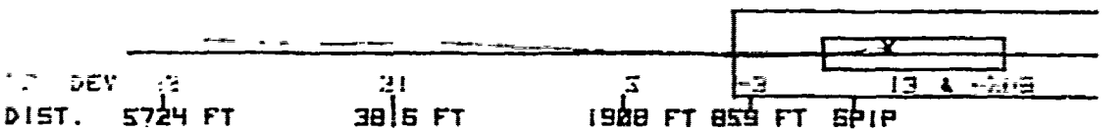
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

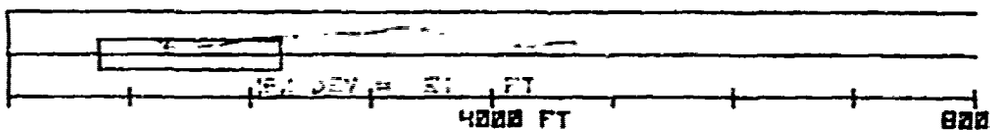
MISSION # 49 - RUN # 5
C-12 AUTO R/W 13
FULL STOP
PILOT'S NAME: STEPHENS



G/S DEVIATION



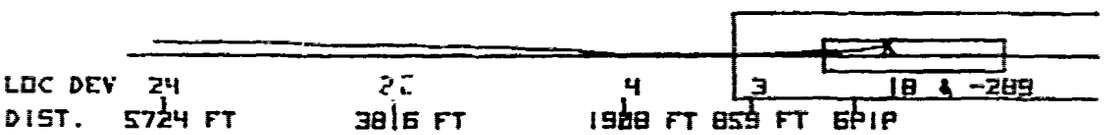
LOC DEVIATION



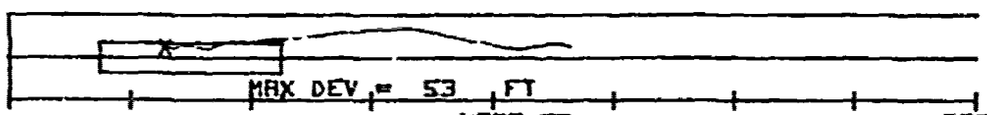
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION



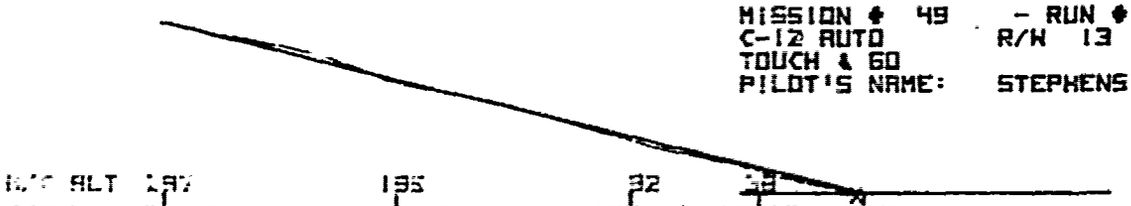
LOC DEVIATION



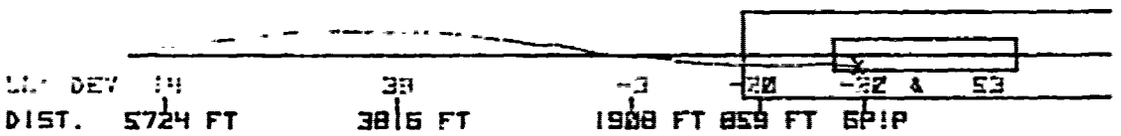
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

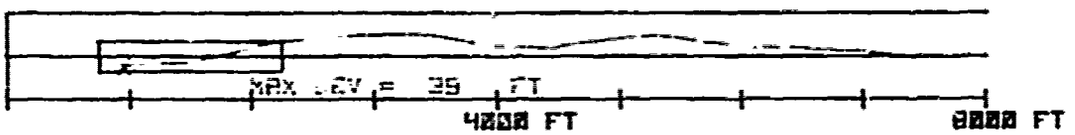
MISSION # 49 - RUN # 7
C-12 AUTO R/W 13
TOUCH & GO
PILOT'S NAME: STEPHENS



G'S DEVIATION

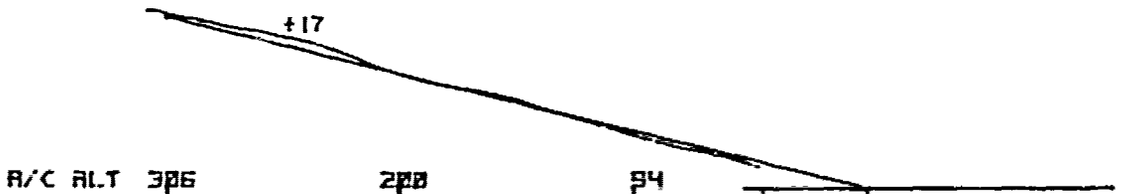


LOC DEVIATION

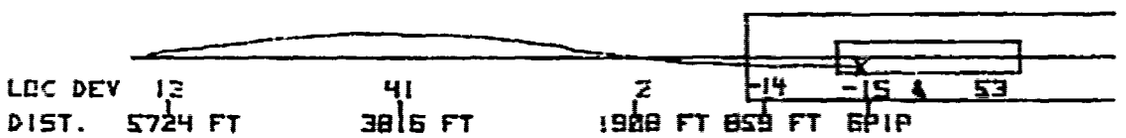


ROLLOUT DEVIATION

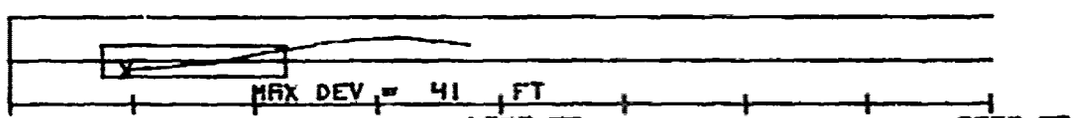
A/C INSTRUMENTATION DATA



G/S DEVIATION



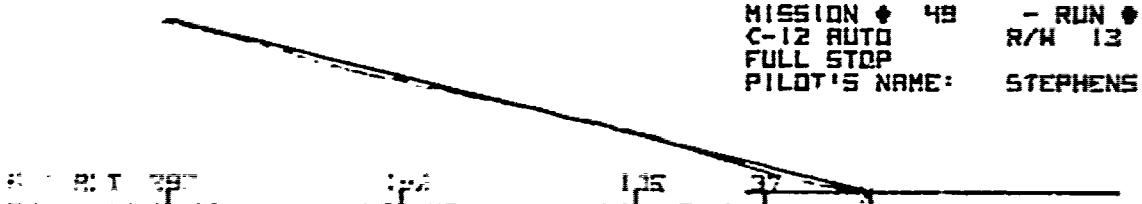
LOC DEVIATION



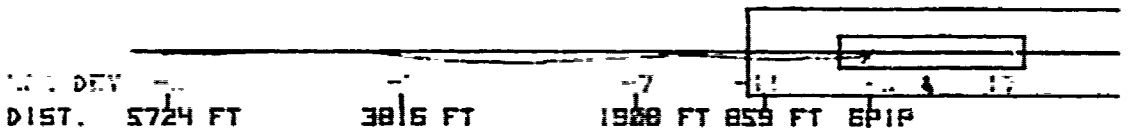
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

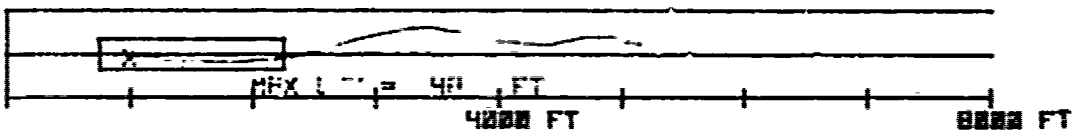
MISSION # 48 - RUN # 9
C-12 AUTO R/W 13
FULL STOP
PILOT'S NAME: STEPHENS



G/S DEVIATION



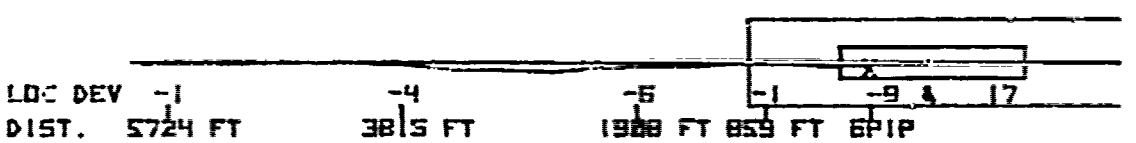
LOC DEVIATION



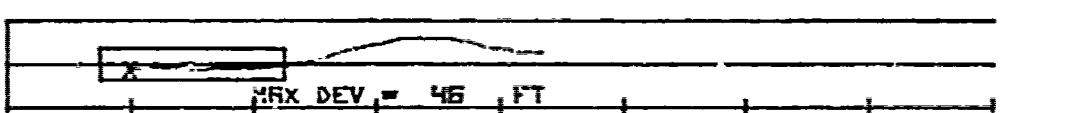
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION



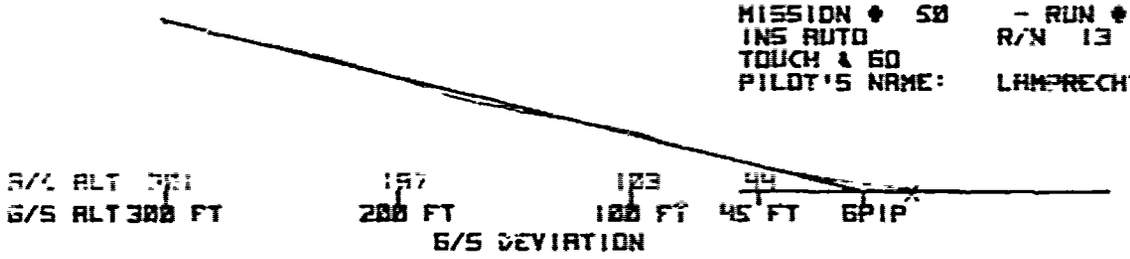
LOC DEVIATION



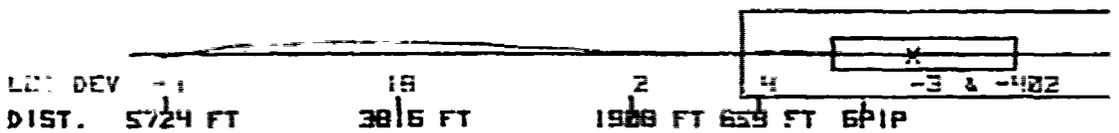
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

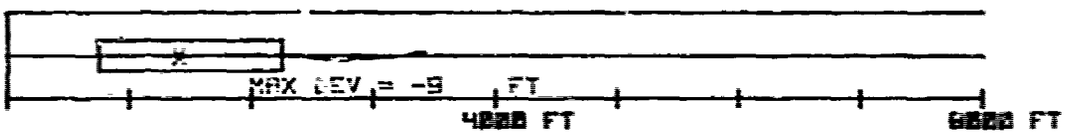
MISSION # 50 - RUN # 1
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

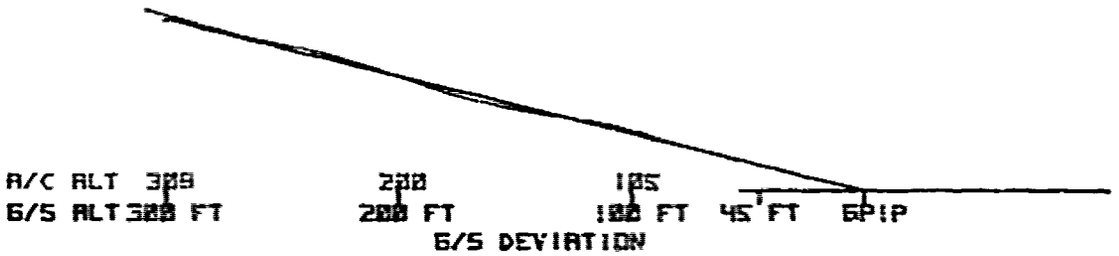


LOC DEVIATION

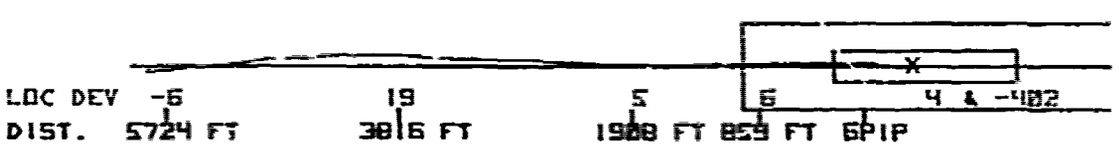


ROLLOUT DEVIATION

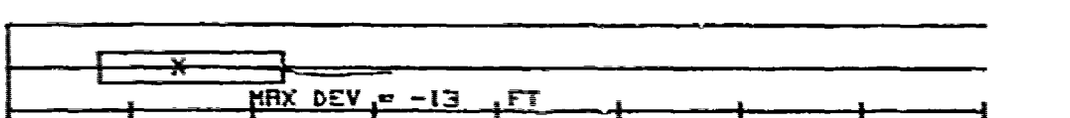
A/C INSTRUMENTATION DATA



G/S DEVIATION



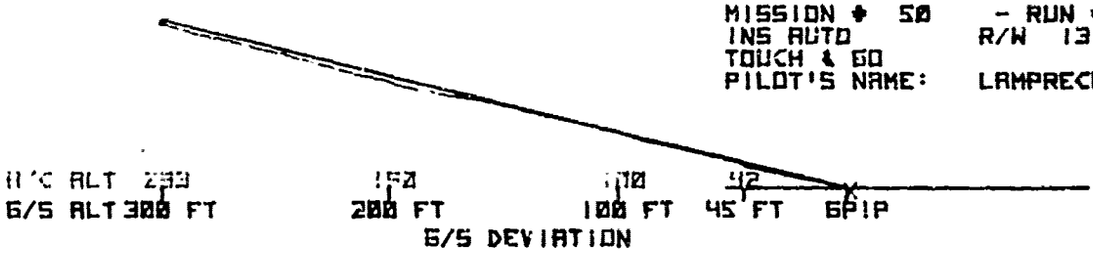
LOC DEVIATION



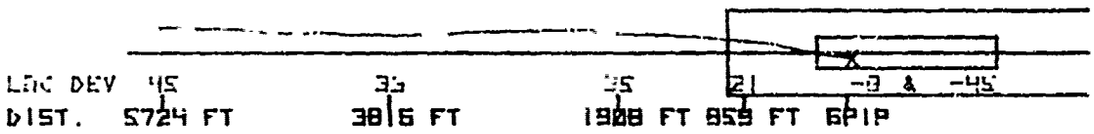
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

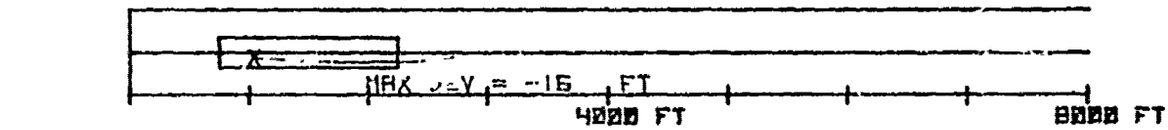
MISSION # 50 - RUN # 2
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

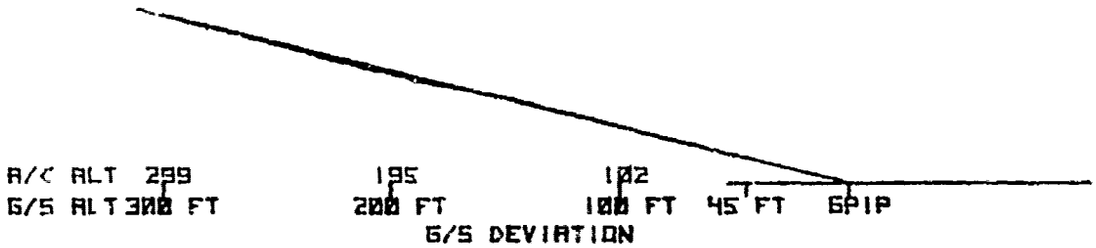


LOC DEVIATION

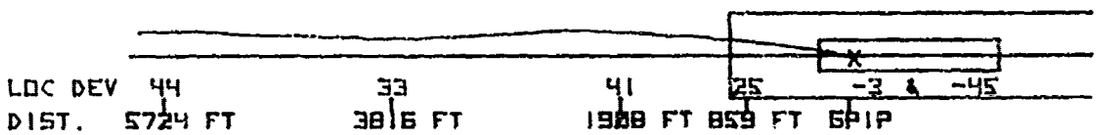


ROLLOUT DEVIATION

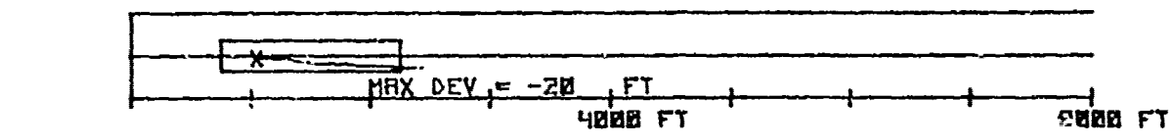
A/C INSTRUMENTATION DATA



G/S DEVIATION



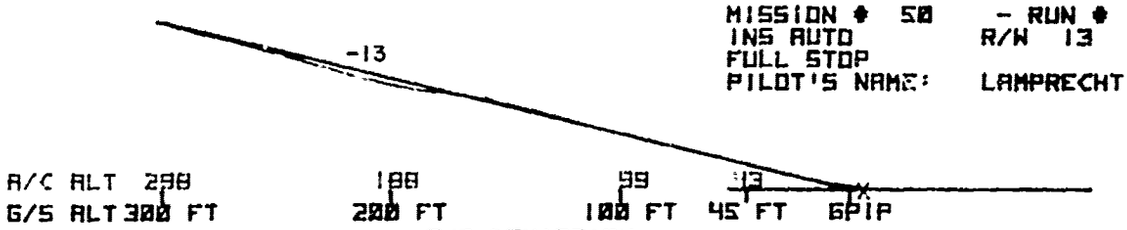
LOC DEVIATION



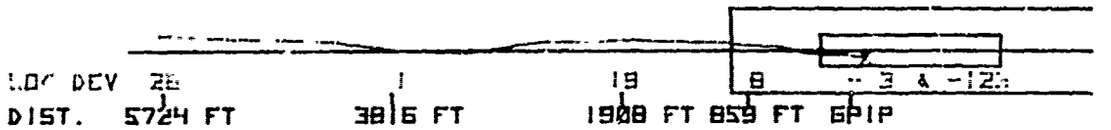
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

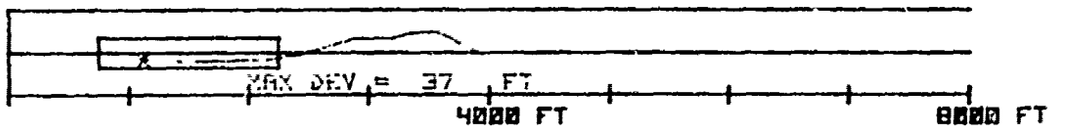
MISSION # 50 - RUN # 4
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

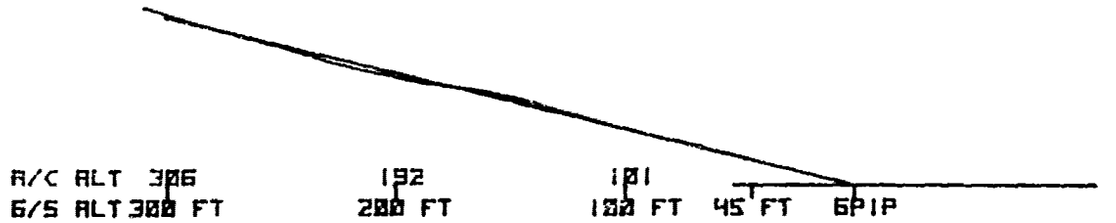


LOC DEVIATION

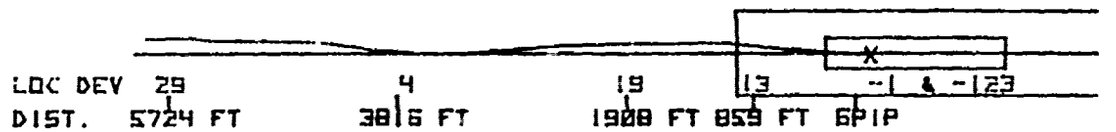


ROLLOUT DEVIATION

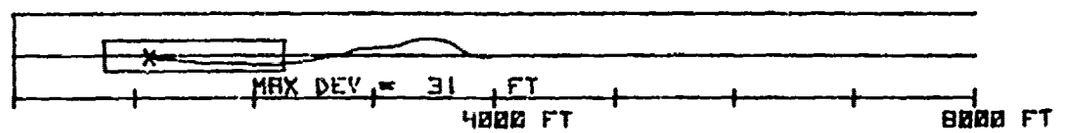
R/C INSTRUMENTATION DATA



G/S DEVIATION



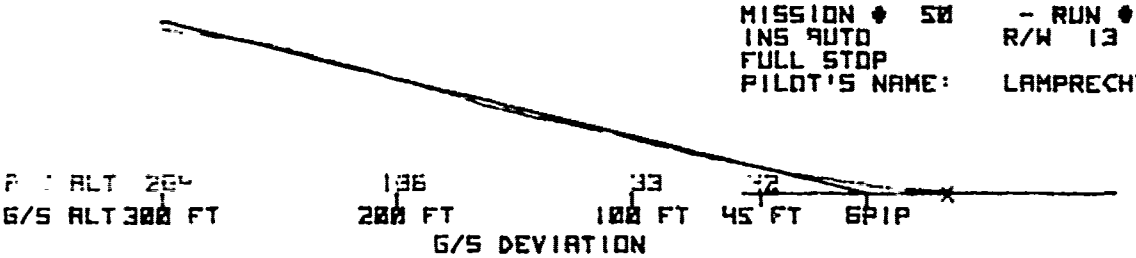
LOC DEVIATION



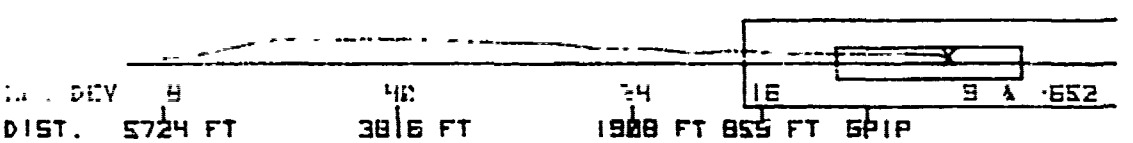
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

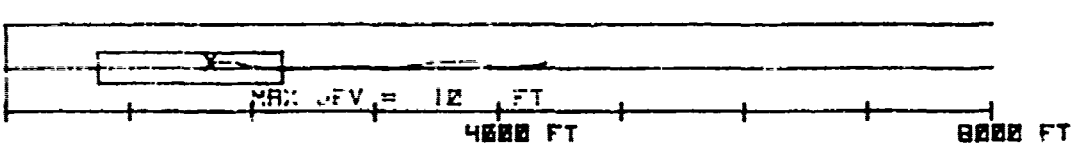
MISSION # 50 - RUN # 5
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

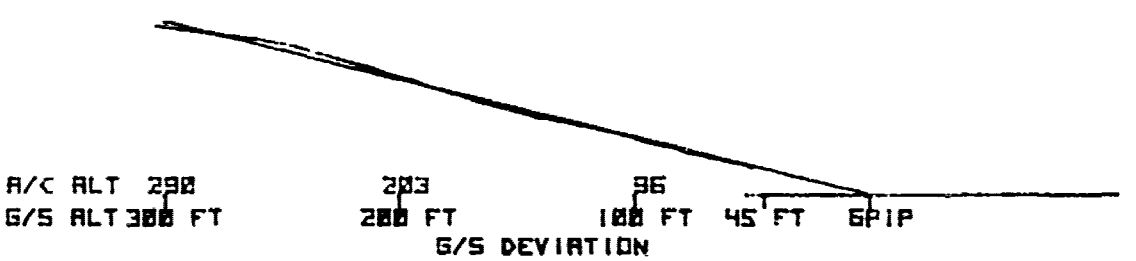


LOC DEVIATION

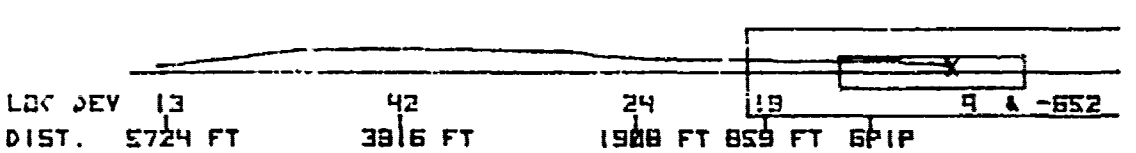


ROLLOUT DEVIATION

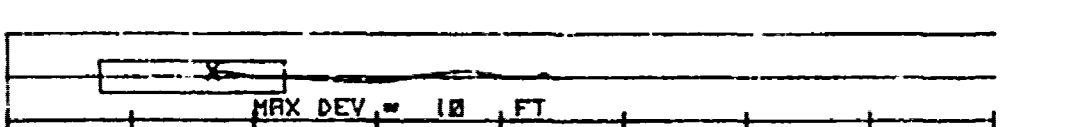
A/C INSTRUMENTATION DATA



G/S DEVIATION



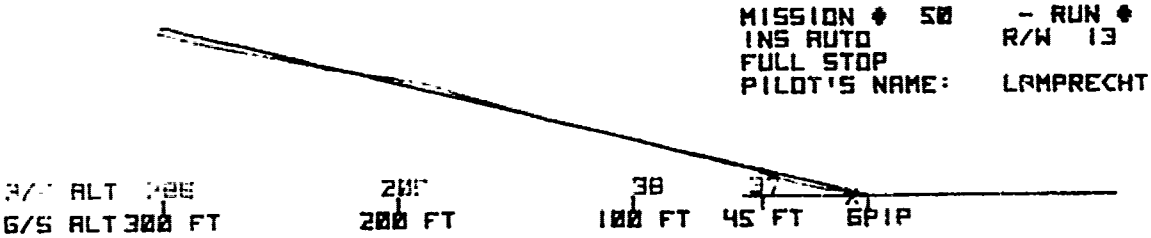
LOC DEVIATION



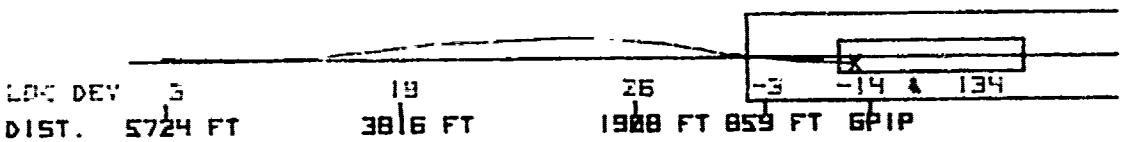
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

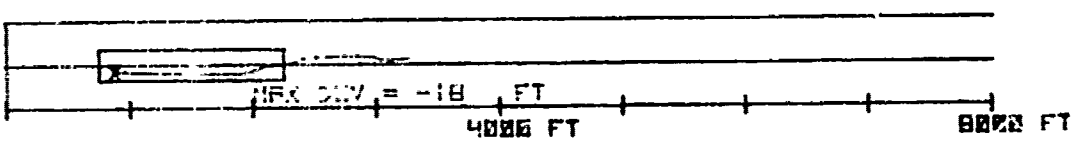
MISSION # 50 - RUN # 7
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

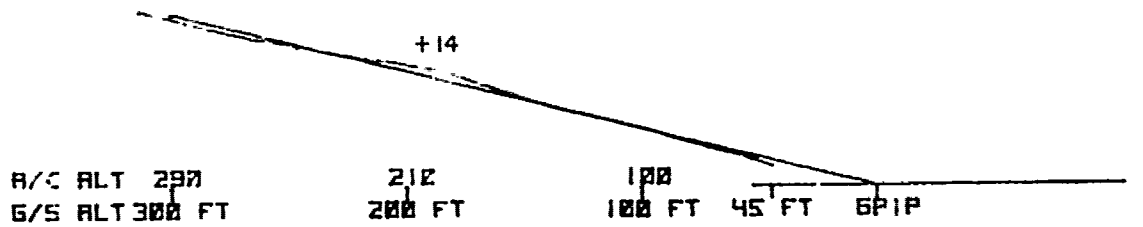


LOC DEVIATION

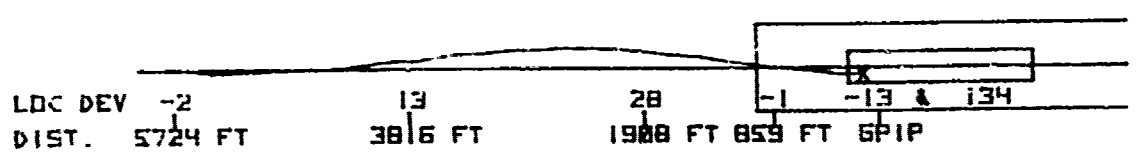


ROLLOUT DEVIATION

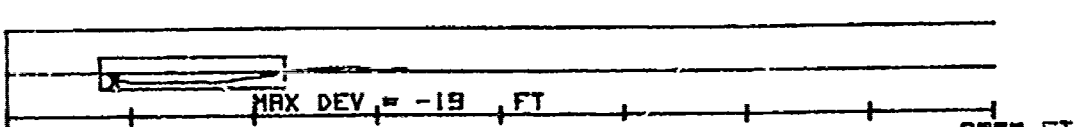
A/C INSTRUMENTATION DATA



G/S DEVIATION



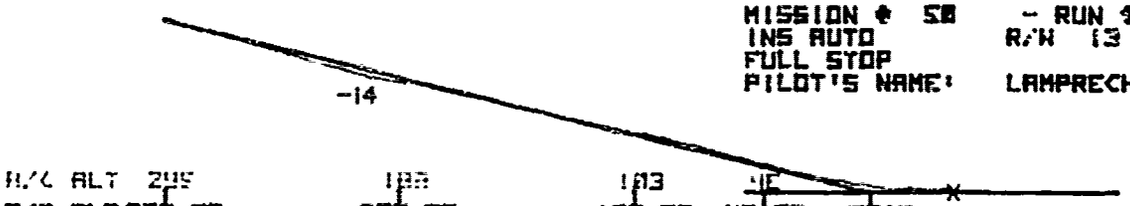
LOC DEVIATION



ROLLOUT DEVIATION

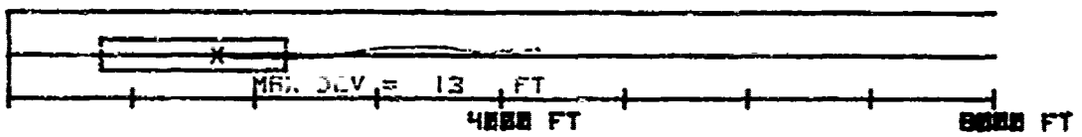
THEODOLITE TRACKING DATA

MISSION # 58 - RUN # 8
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

LOC DEVIATION

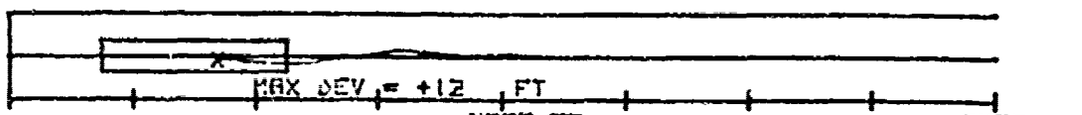


ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION

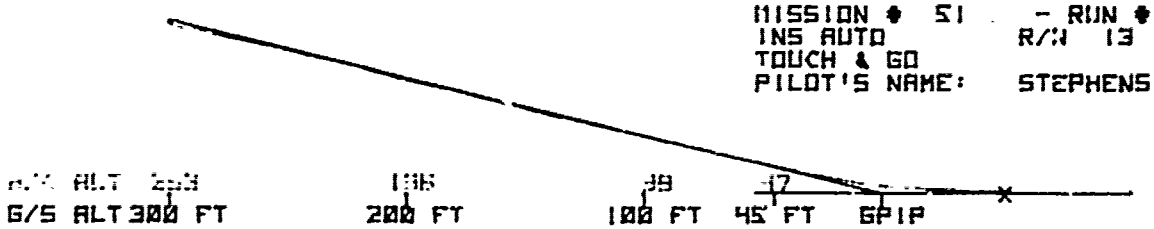
LOC DEVIATION



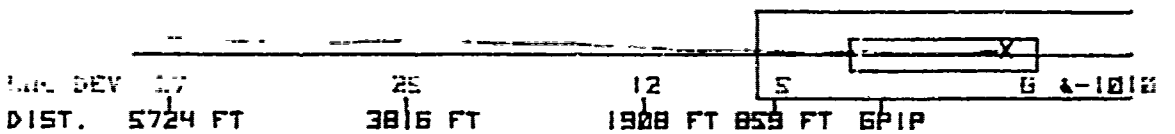
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

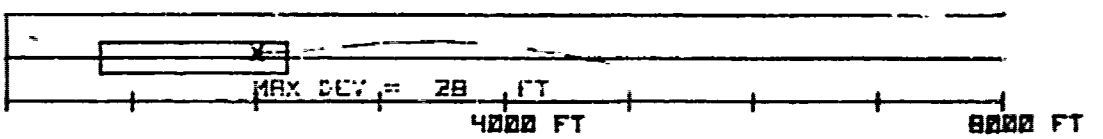
MISSION # 51 - RUN # 1
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: STEPHENS



G/S DEVIATION

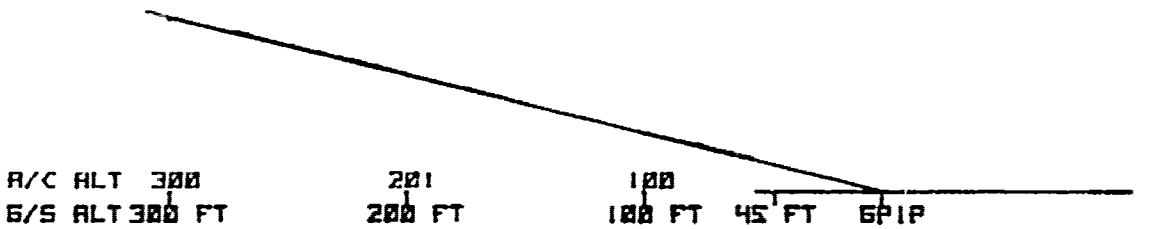


LOC DEVIATION

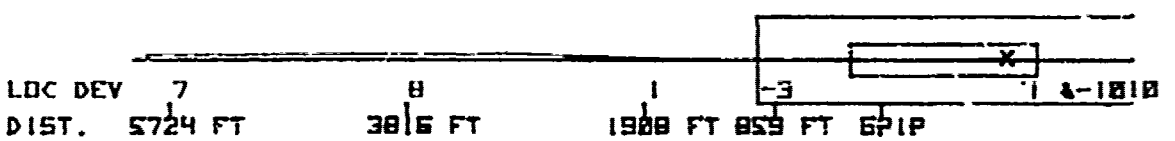


ROLLOUT DEVIATION

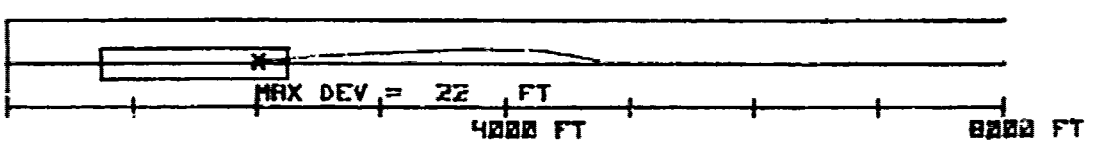
A/C INSTRUMENTATION DATA



G/S DEVIATION



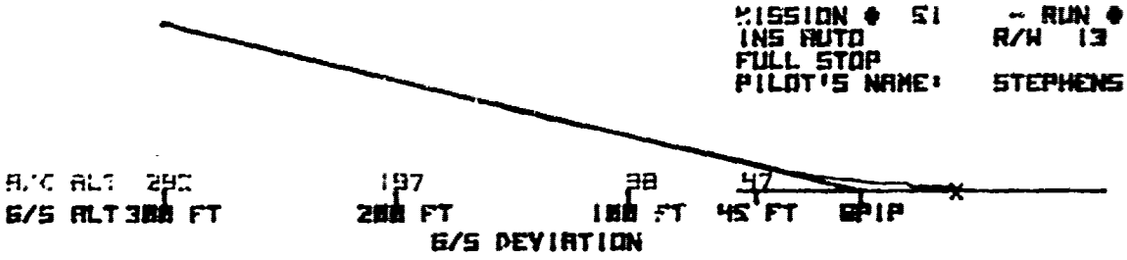
LOC DEVIATION



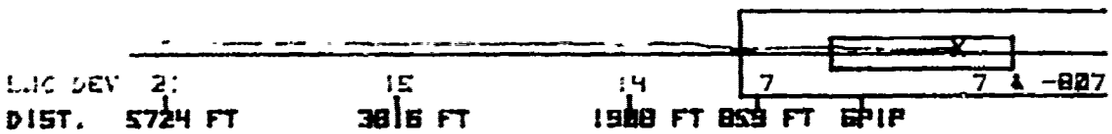
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

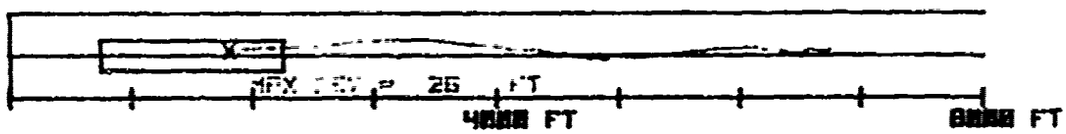
MISSION # 51 - RUN # 2
INS AUTO R/W 13
FULL STOP
PILOT'S NAME: STEPHENS



G/S DEVIATION

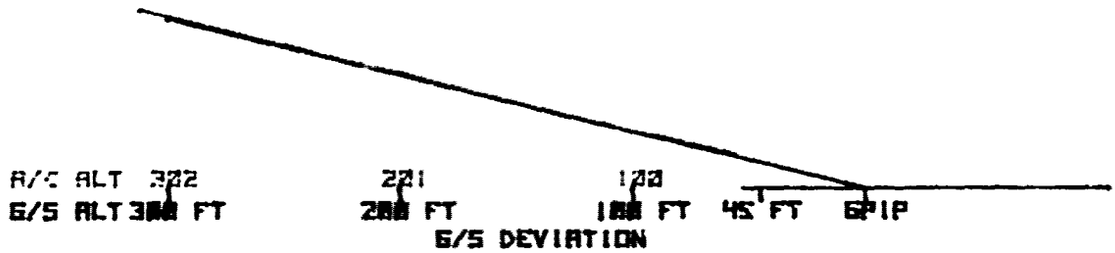


LOC DEVIATION

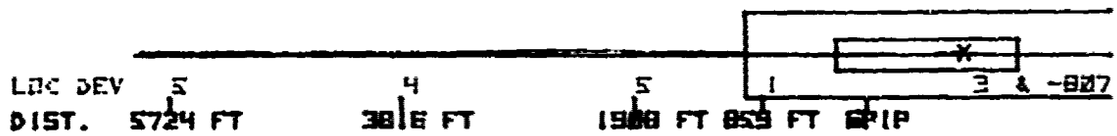


ROLLOUT DEVIATION

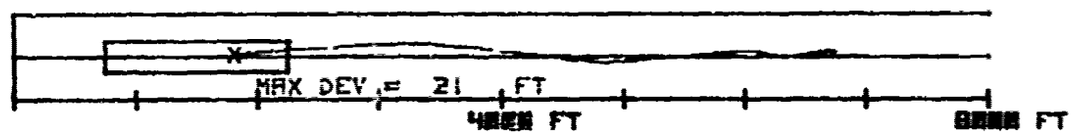
A/C INSTRUMENTATION DATA



G/S DEVIATION



LOC DEVIATION

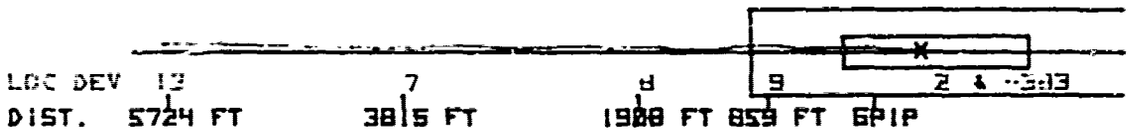


ROLLOUT DEVIATION

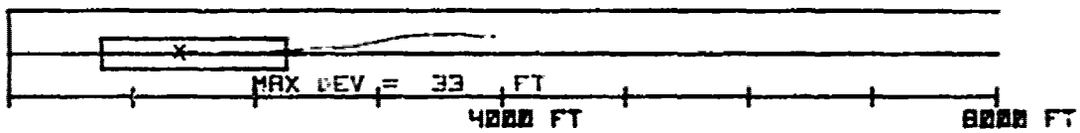
THEODOLITE TRACKING DATA

MISSION # 51 . - RUN # 3
INS AUTO R/W 13
TOUCH & GO
PILOT'S NAME: STEPHENS

G/S DEVIATION



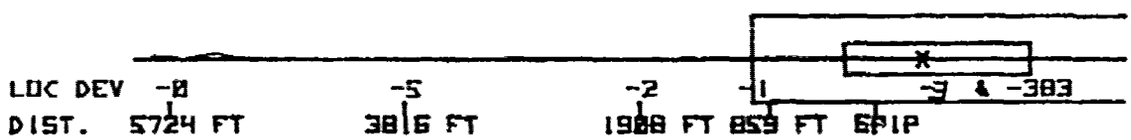
LOC DEVIATION



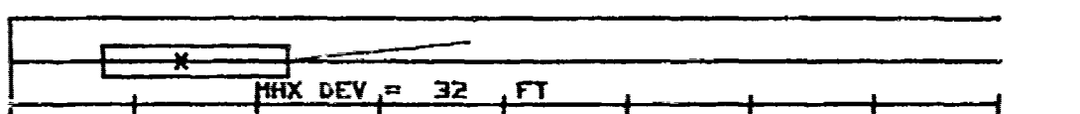
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION



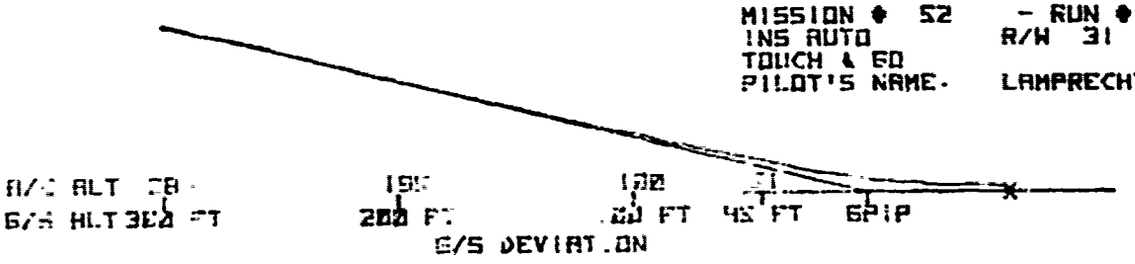
LOC DEVIATION



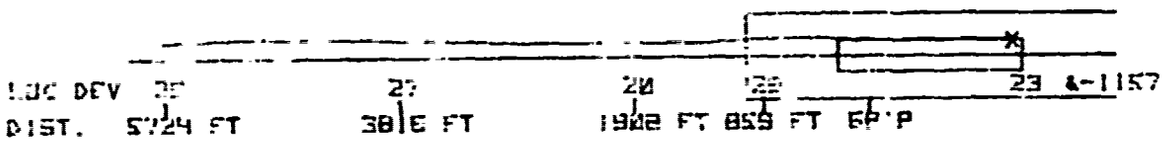
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

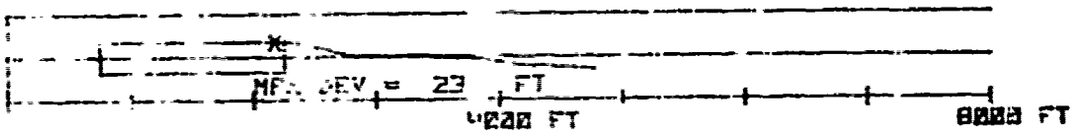
MISSION # 52 - RUN # 1
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME- LAMPRECHT



G/S DEVIATION

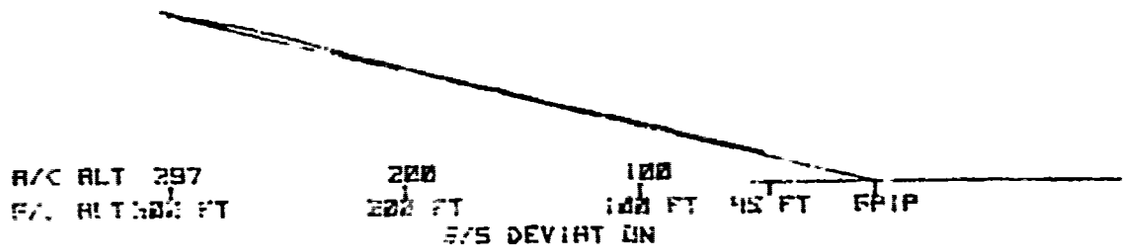


LOC DEVIATION

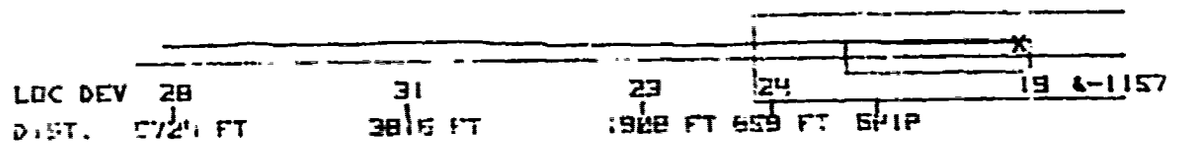


ROLLOUT DEVIATION

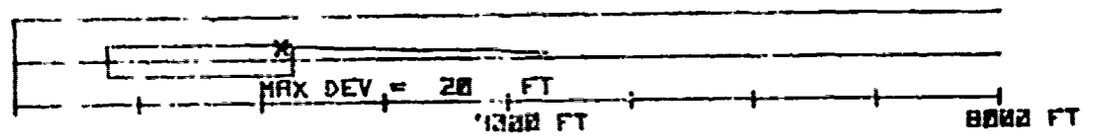
A/C INSTRUMENTATION DATA



G/S DEVIATION



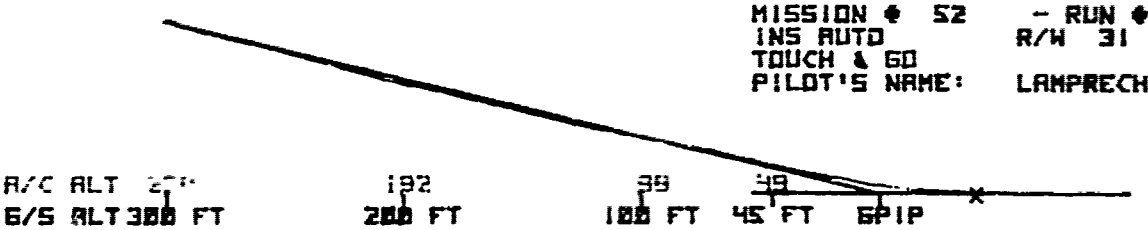
LOC DEVIATION



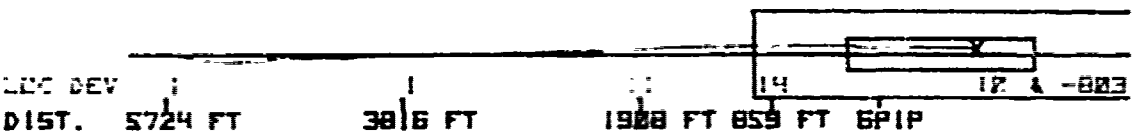
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

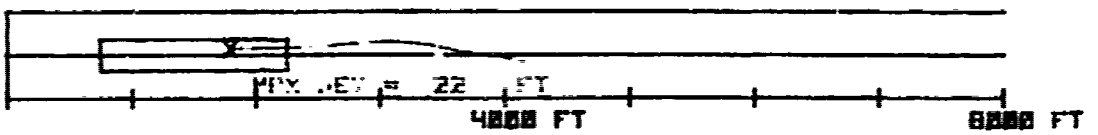
MISSION # 52 - RUN # 4
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION



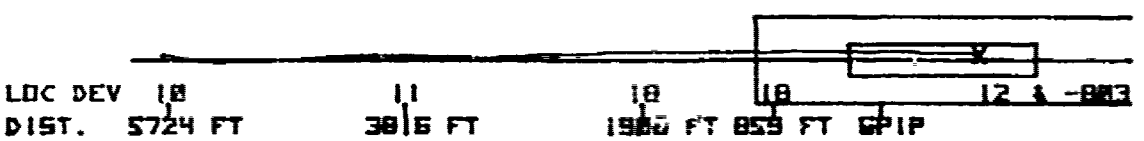
LOC DEVIATION



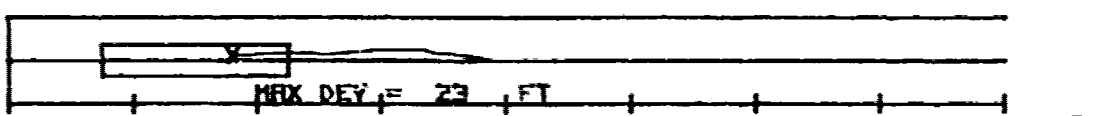
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION



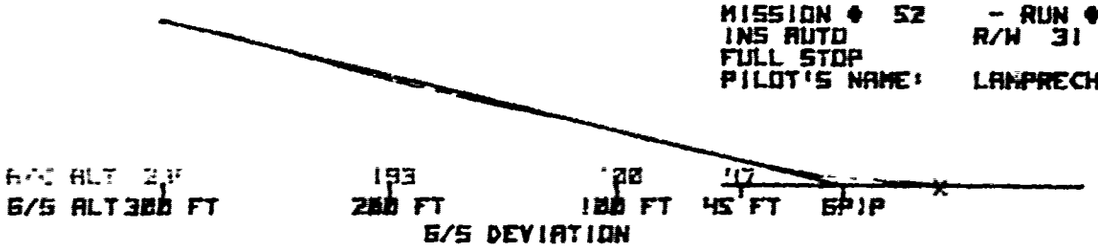
LOC DEVIATION



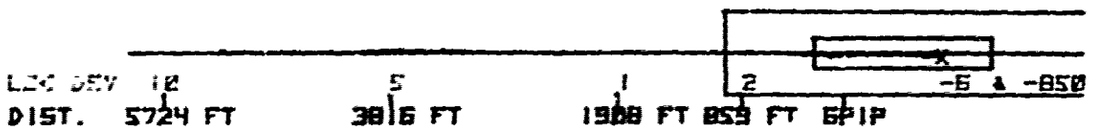
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

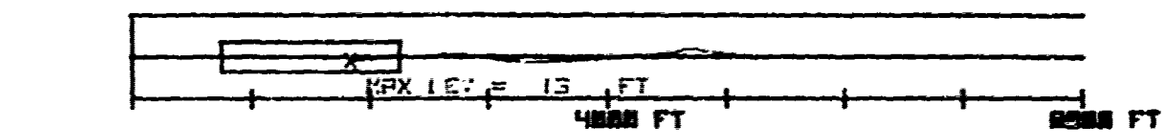
MISSION # 52 - RUN # 6
INS AUTO R/W 31
FULL STOP
PILOT'S NAME: LANPRECHT



G/S DEVIATION

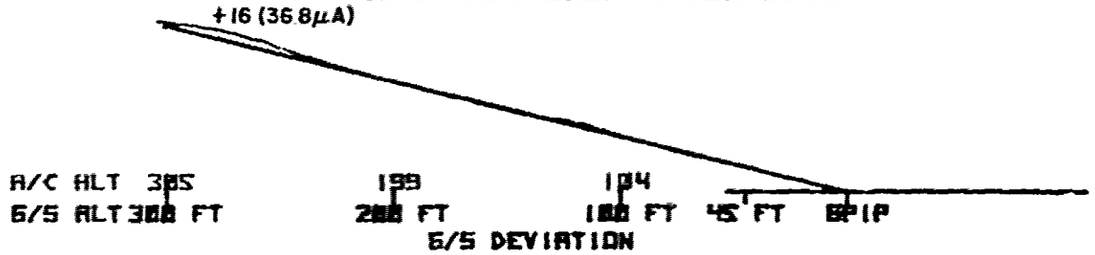


LOC DEVIATION

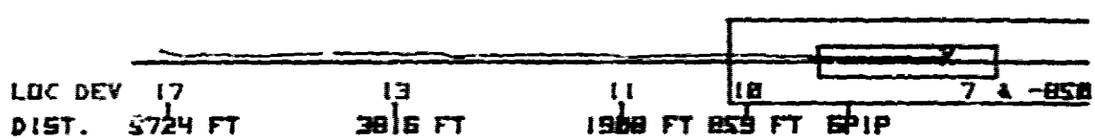


ROLLOUT DEVIATION

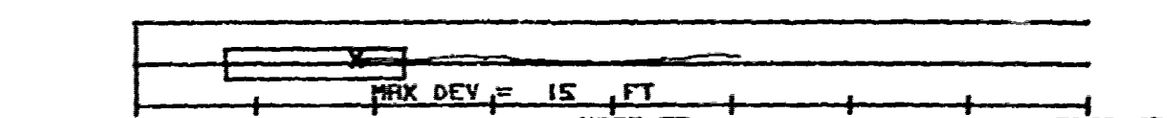
A/C INSTRUMENTATION DATA



G/S DEVIATION



LOC DEVIATION

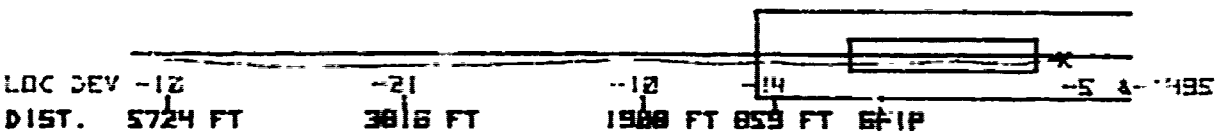


ROLLOUT DEVIATION

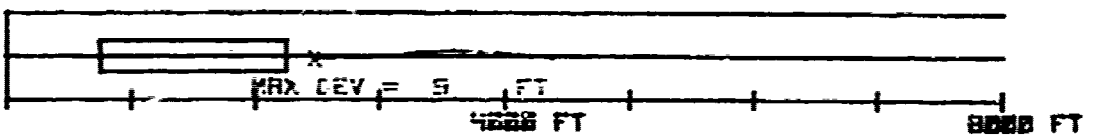
THEODOLITE TRACKING DATA

MISSION # 52 - RUN # 7
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT

G/S DEVIATION



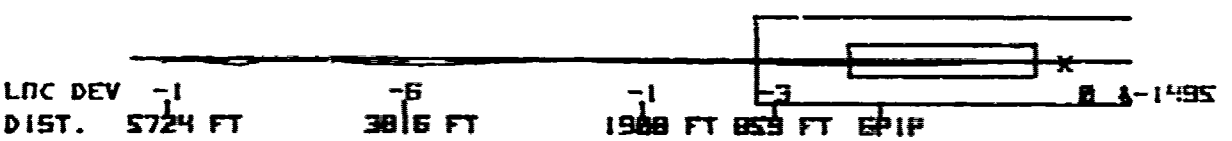
LOC DEVIATION



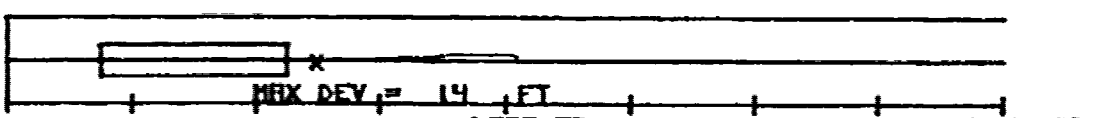
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION



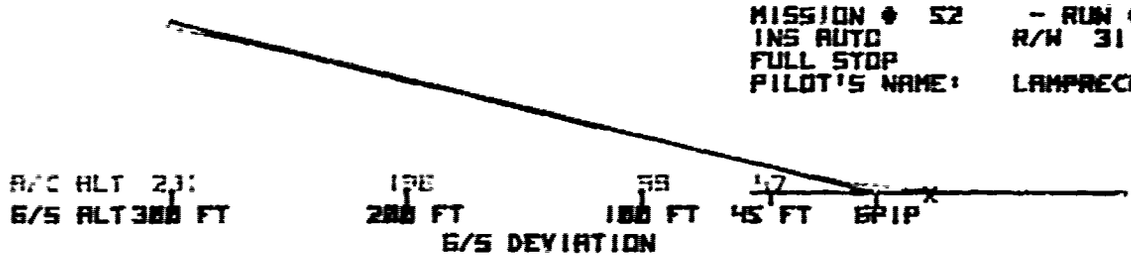
LOC DEVIATION

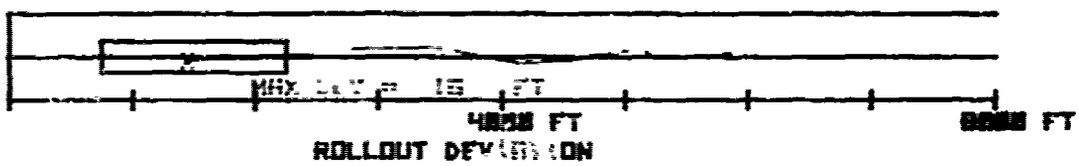


ROLLOUT DEVIATION

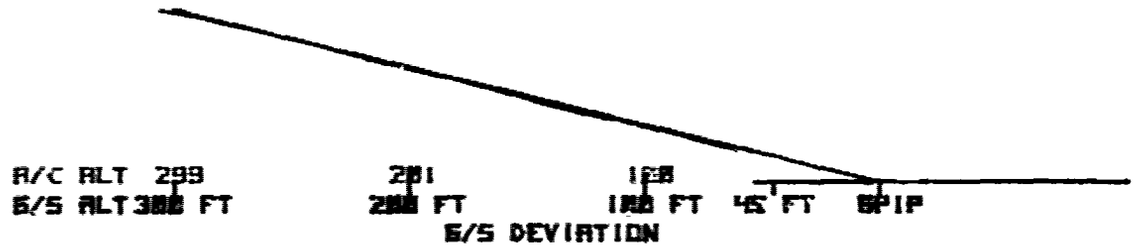
THEODOLITE TRACKING DATA

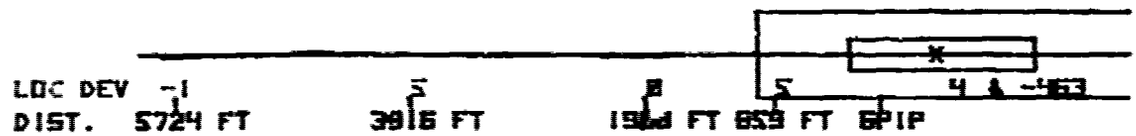
MISSION # 52 - RUN # 8
INS AUTO R/W 31
FULL STOP
PILOT'S NAME: LAMPRECHT

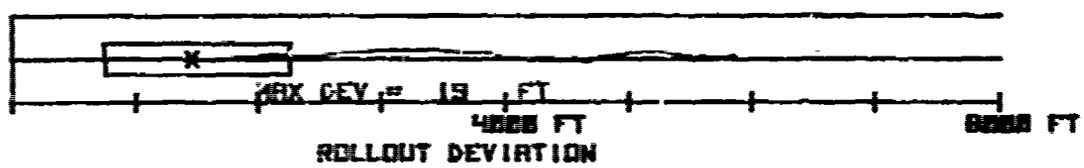




A/C INSTRUMENTATION DATA

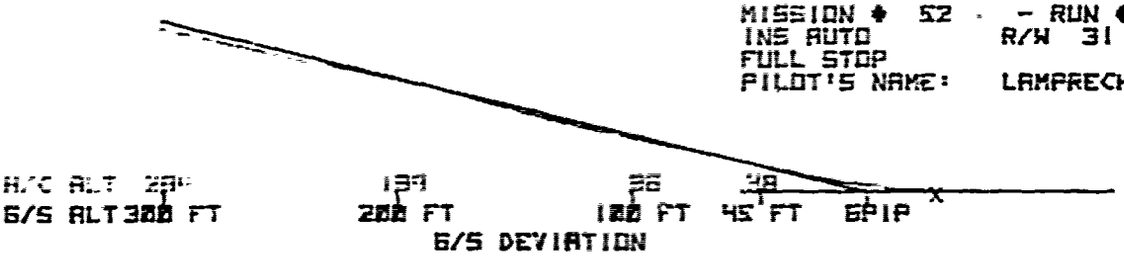




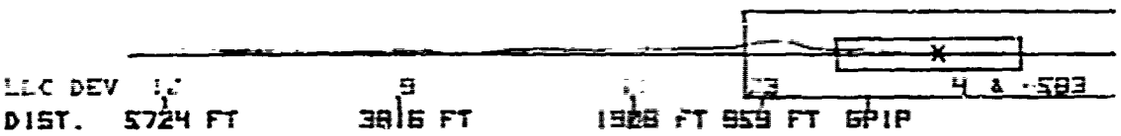


THEODOLITE TRACKING DATA

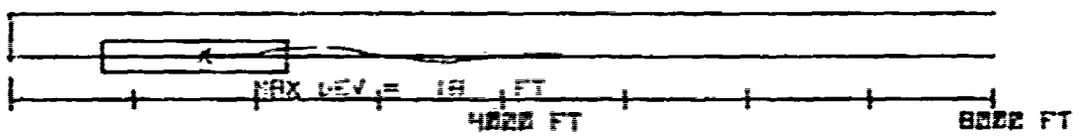
MISSION # 52 - RUN # 9
INS AUTO R/W 31
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

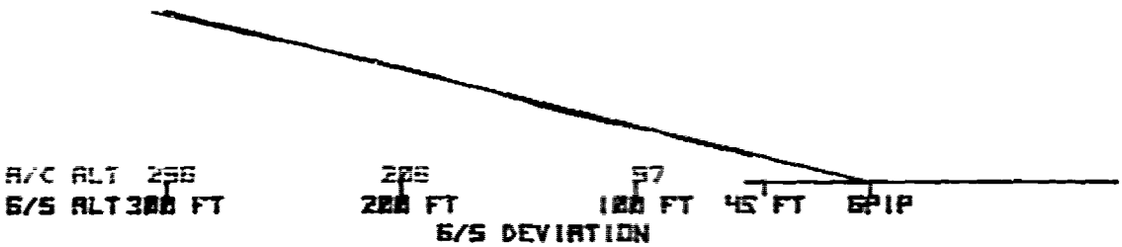


LOC DEVIATION

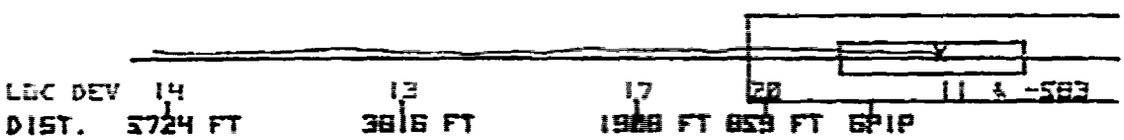


ROLLOUT DEVIATION

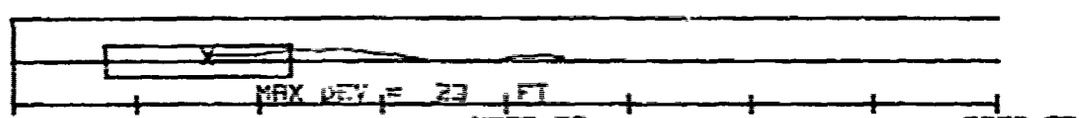
A/C INSTRUMENTATION DATA



G/S DEVIATION



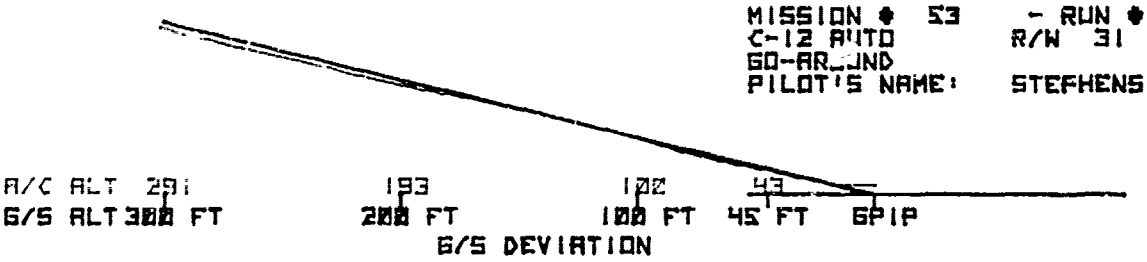
LOC DEVIATION



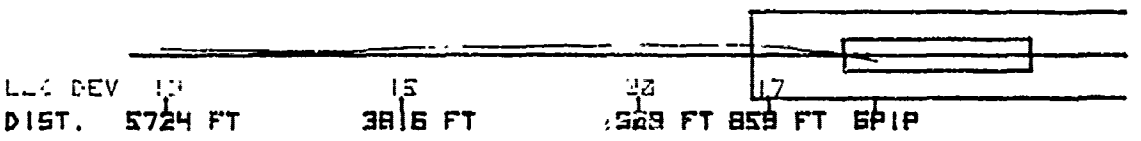
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

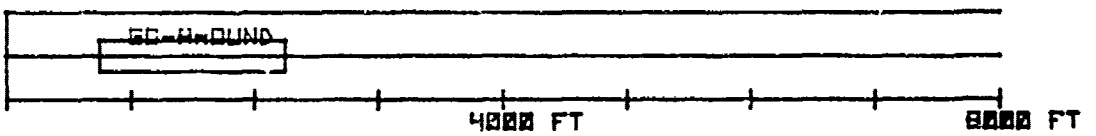
MISSION # 53 - RUN # 1
C-12 AUTO R/W 31
GO-AROUND
PILOT'S NAME: STEPHENS



G/S DEVIATION

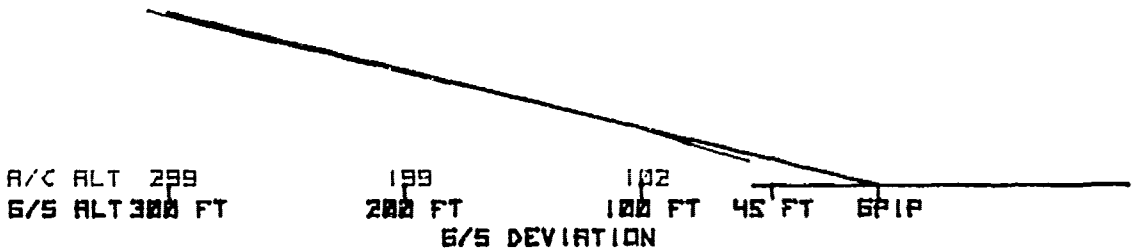


LOC DEVIATION

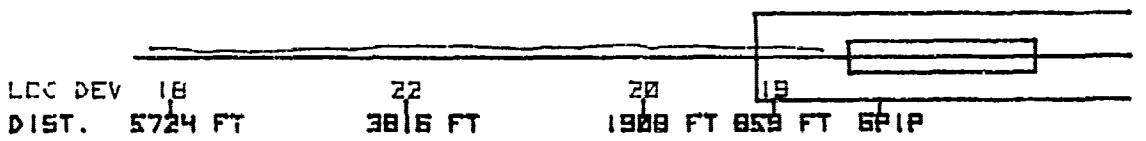


ROLLOUT DEVIATION

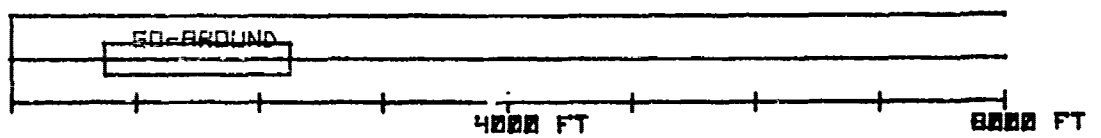
A/C INSTRUMENTATION DATA



G/S DEVIATION



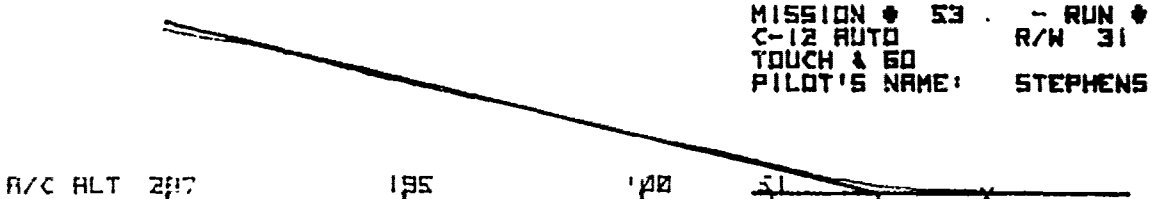
LOC DEVIATION



ROLLOUT DEVIATION

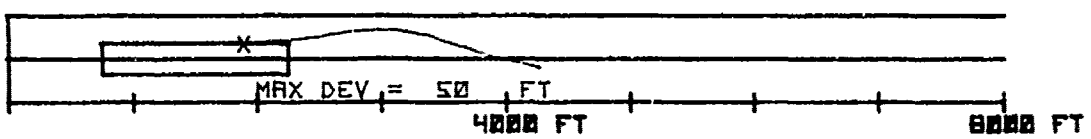
THEODOLITE TRACKING DATA

MISSION # 53 - RUN # 2
C-12 AUTO R/W 31
TOUCH & GO
PILOT'S NAME: STEPHENS



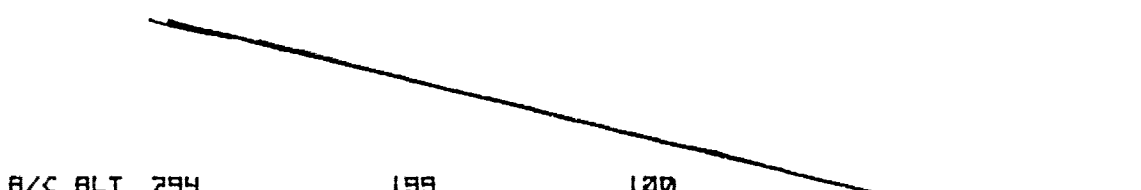
G/S DEVIATION

LOC DEVIATION

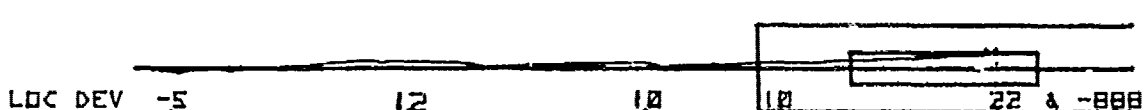


ROLLOUT DEVIATION

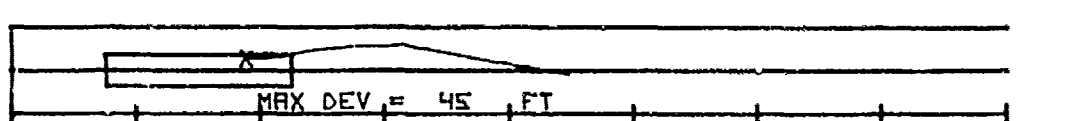
A/C INSTRUMENTATION DATA



G/S DEVIATION

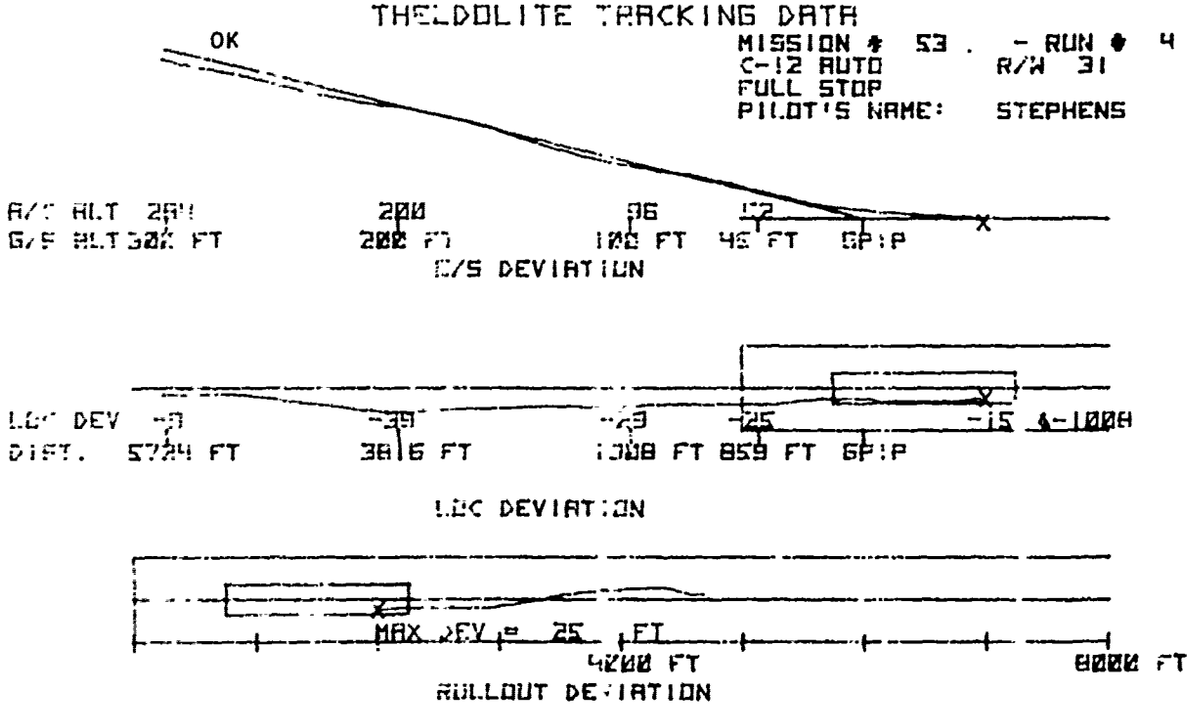


LOC DEVIATION

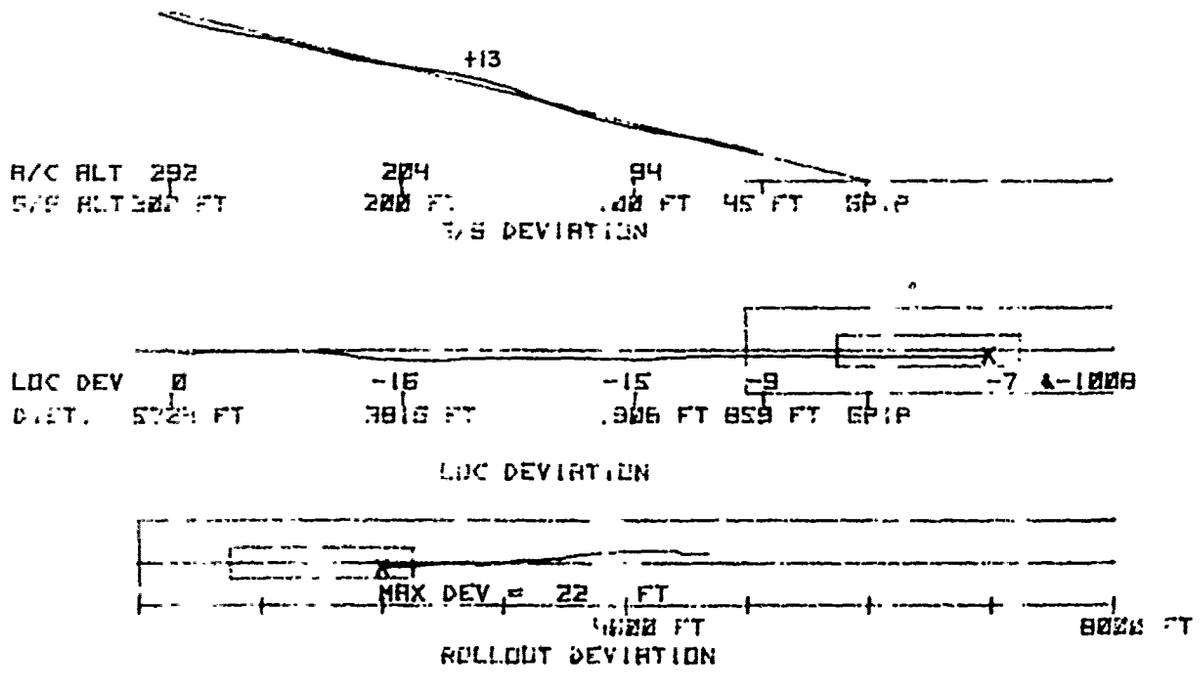


ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

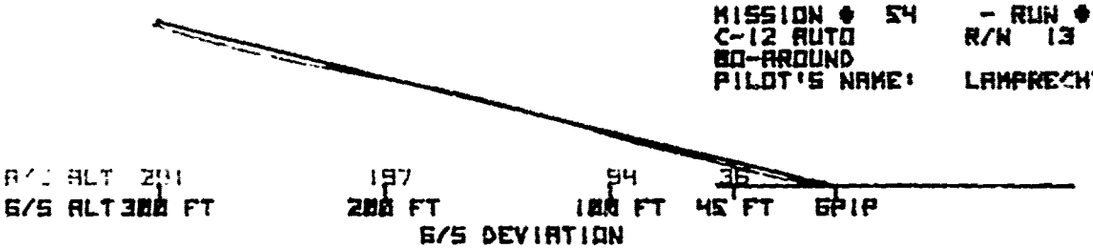


A/C INSTRUMENTATION DATA

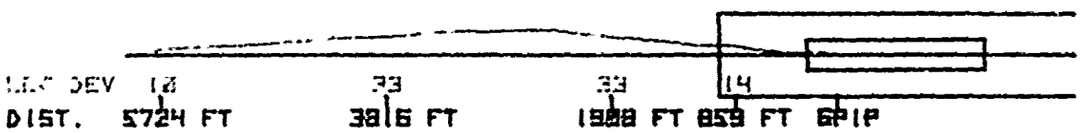


THEODOLITE TRACKING DATA

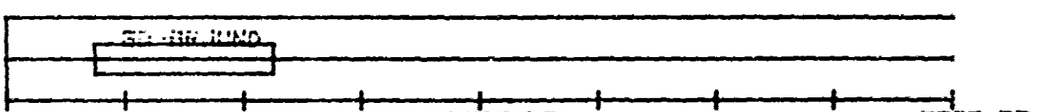
MISSION # 54 - RUN # 1
C-12 AUTO R/N 13
GO-AROUND
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

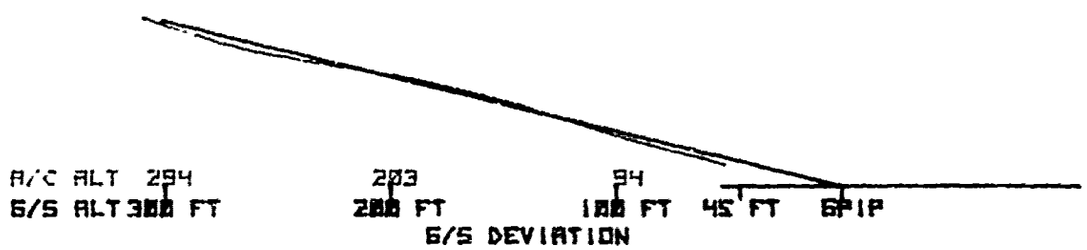


LOC DEVIATION

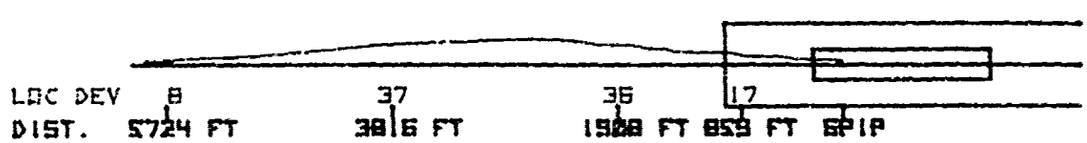


ROLLOUT DEVIATION

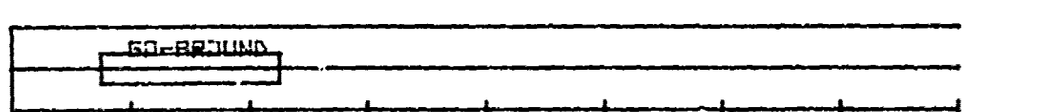
A/C INSTRUMENTATION DATA



G/S DEVIATION



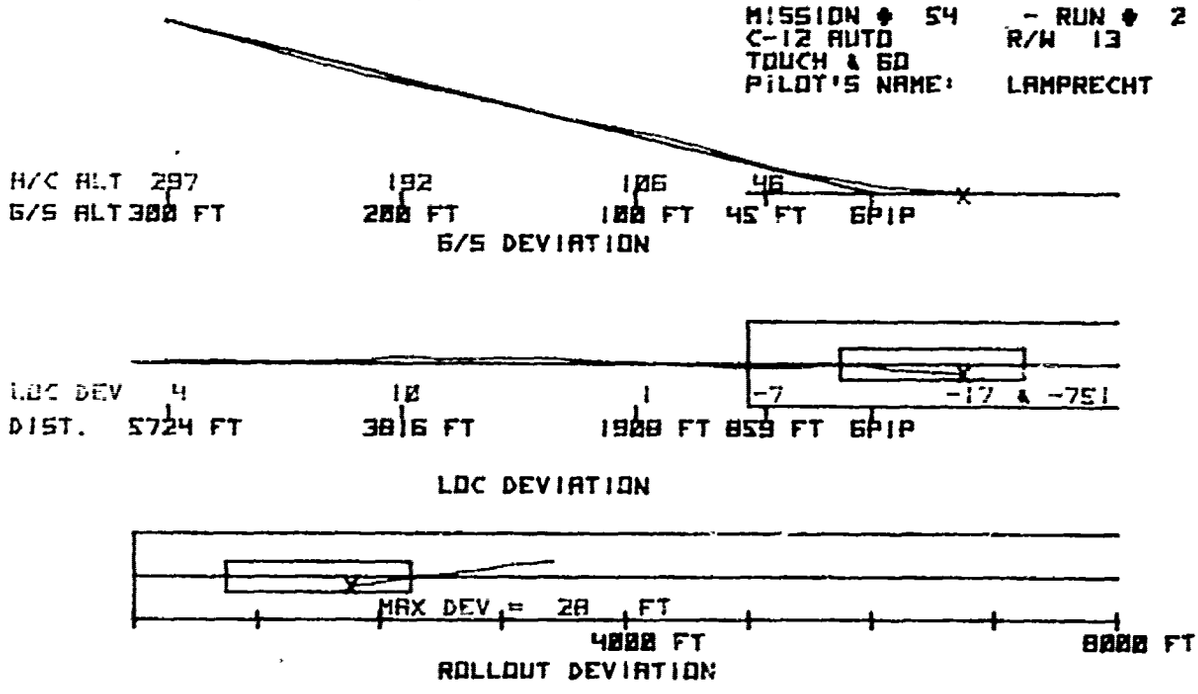
LOC DEVIATION



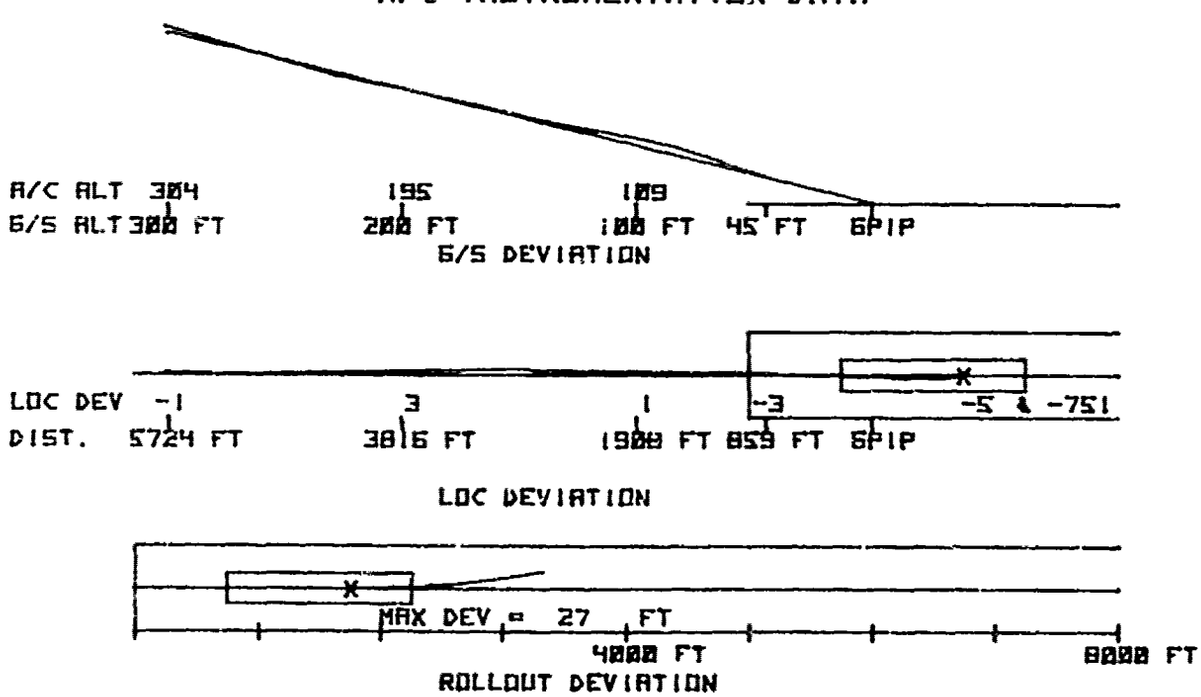
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

MISSION # 54 - RUN # 2
C-12 AUTO R/W 13
TOUCH & GO
PILOT'S NAME: LAMPRECHT

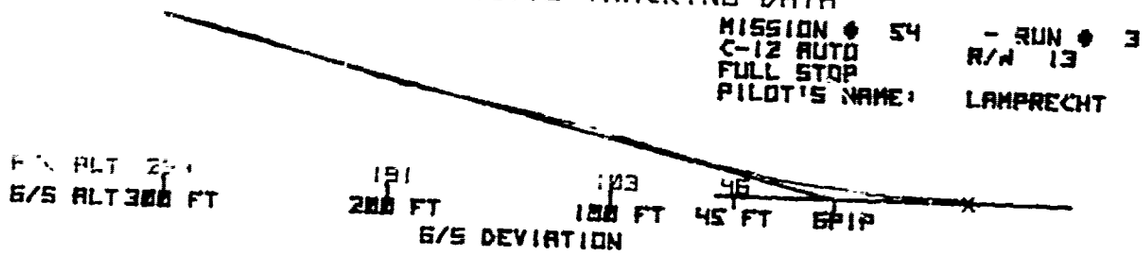


A/C INSTRUMENTATION DATA

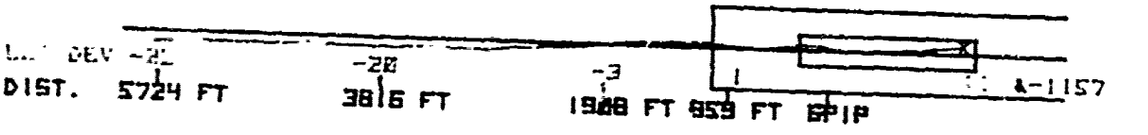


THEODOLITE TRACKING DATA

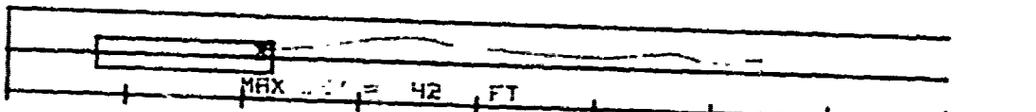
MISSION # 54 - RUN # 3
C-12 AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

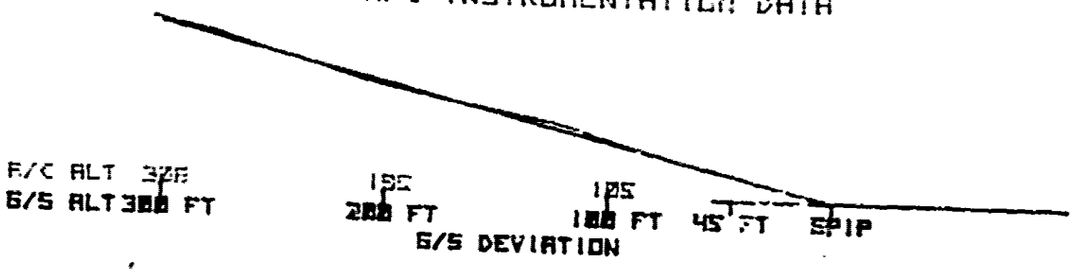


LOC DEVIATION

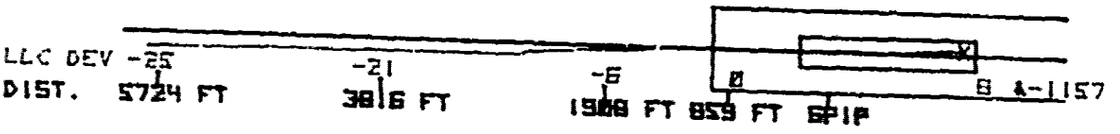


ROLLOUT DEVIATION

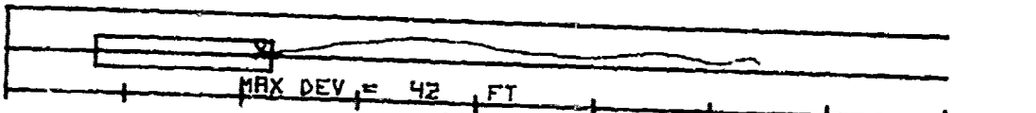
A/C INSTRUMENTATION DATA



G/S DEVIATION



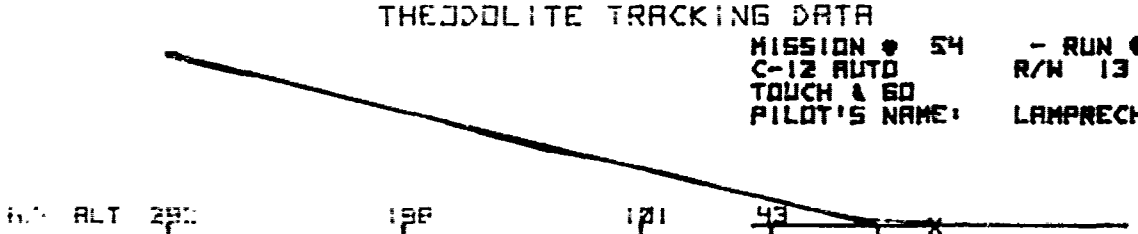
LOC DEVIATION



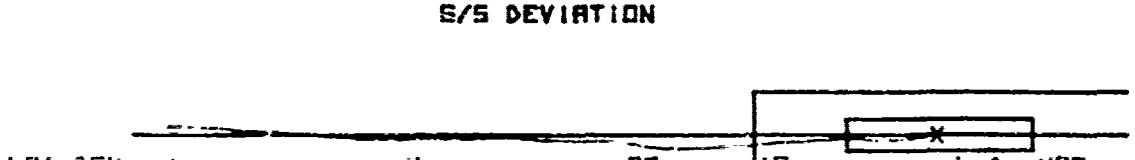
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

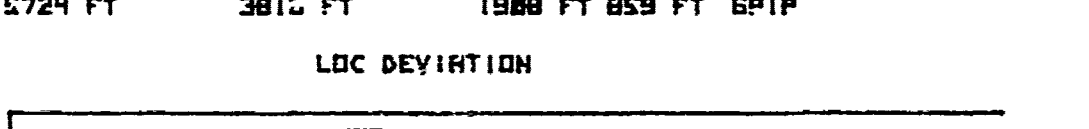
MISSION # 54 - RUN # 4
C-12 AUTO R/W 13
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

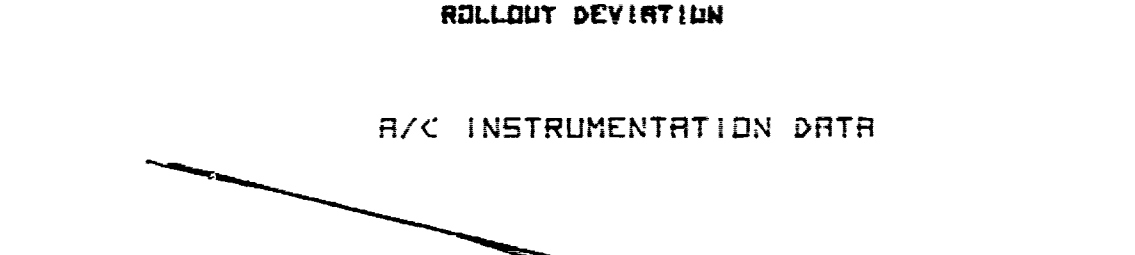


LOC DEVIATION



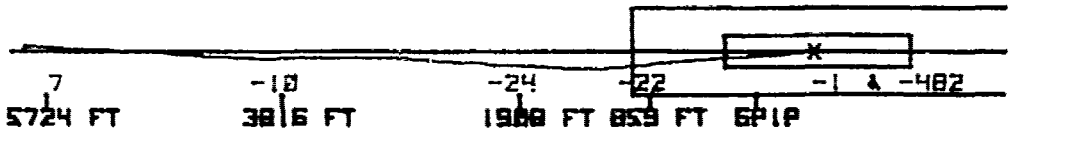
ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA



G/S DEVIATION

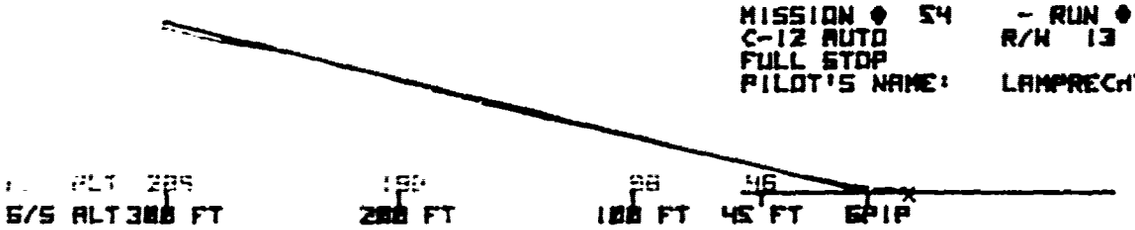
LOC DEVIATION



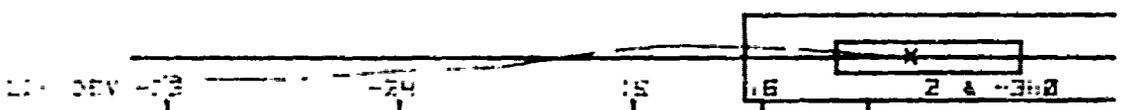
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

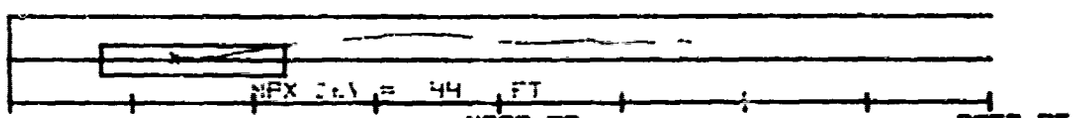
MISSION # 54 - RUN # 6
C-12 AUTO R/W 13
FULL STOP
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

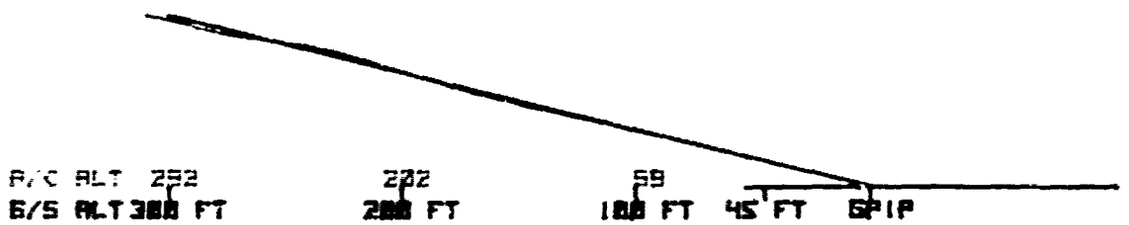


LOC DEVIATION

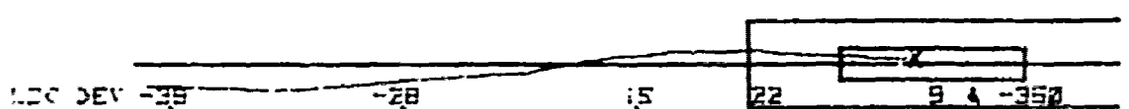


ROLLOUT DEVIATION

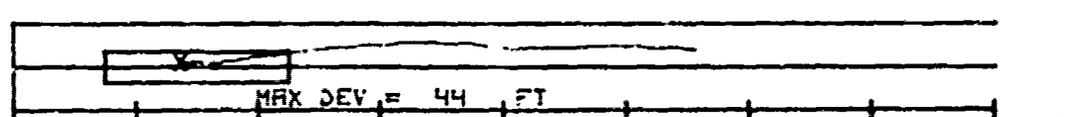
A/C INSTRUMENTATION DATA



G/S DEVIATION



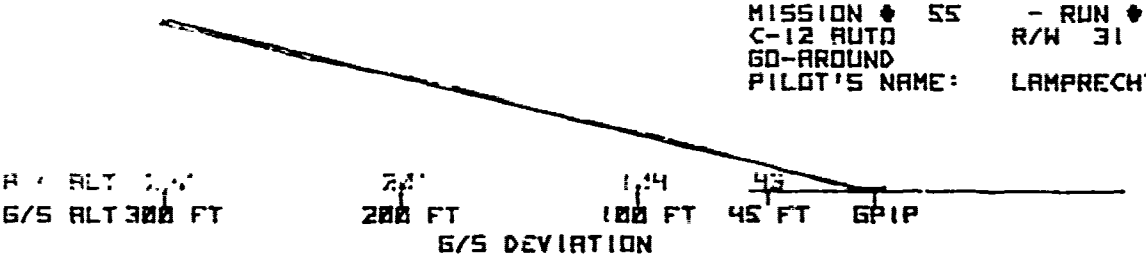
LOC DEVIATION



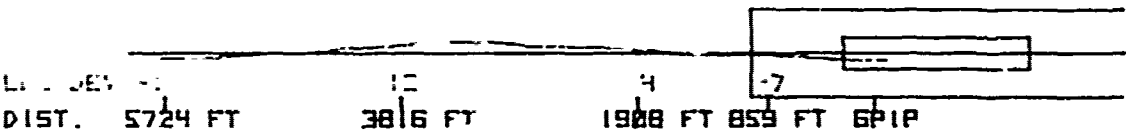
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

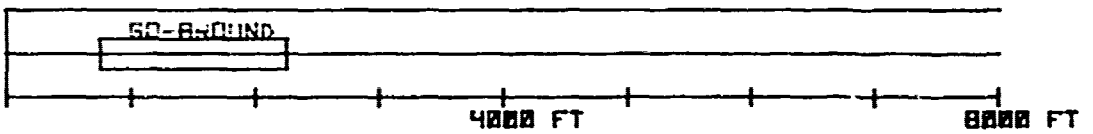
MISSION # 55 - RUN # 5
C-12 AUTO R/W 31
GO-AROUND
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

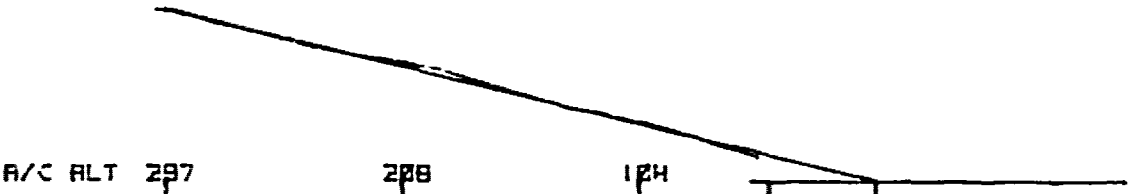


LOC DEVIATION

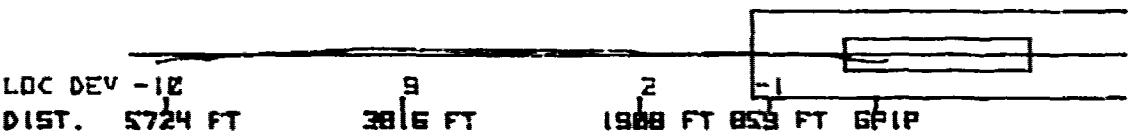


ROLLOUT DEVIATION

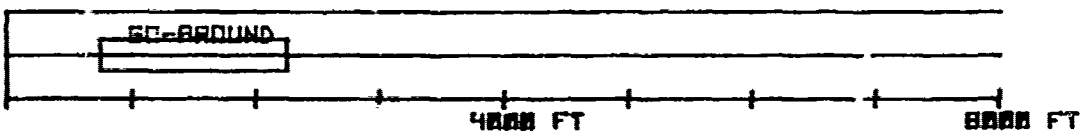
A/C INSTRUMENTATION DATA



G/S DEVIATION



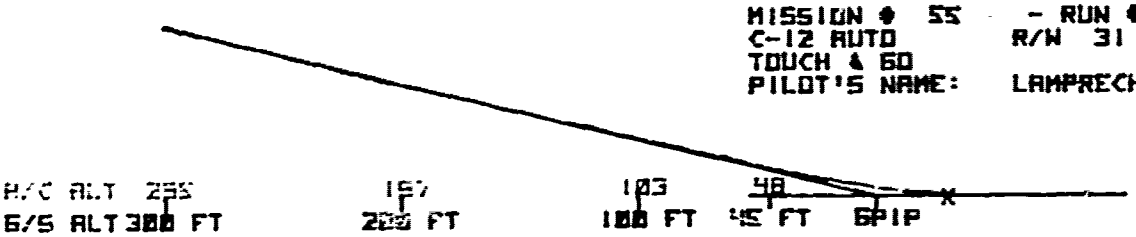
LOC DEVIATION



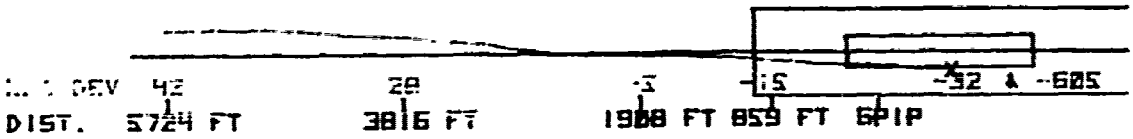
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

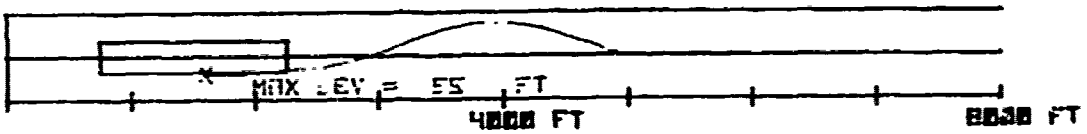
MISSION # 55 - RUN # 6
C-12 AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

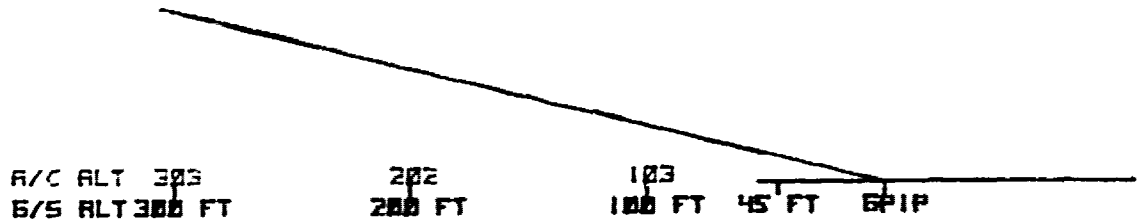


LOC DEVIATION

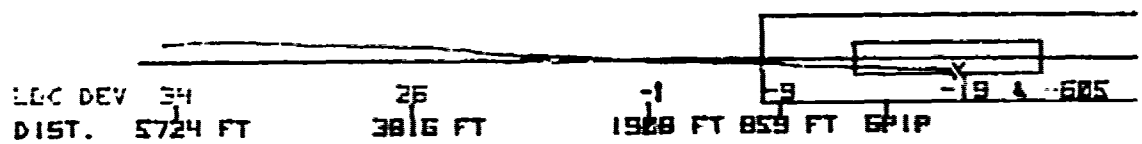


ROLLOUT DEVIATION

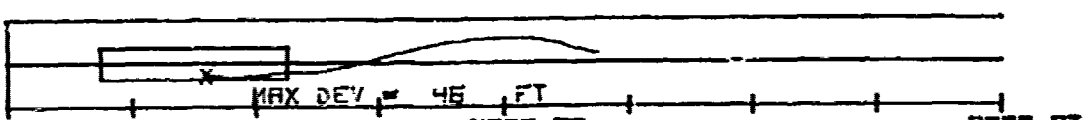
A/C INSTRUMENTATION DATA



G/S DEVIATION



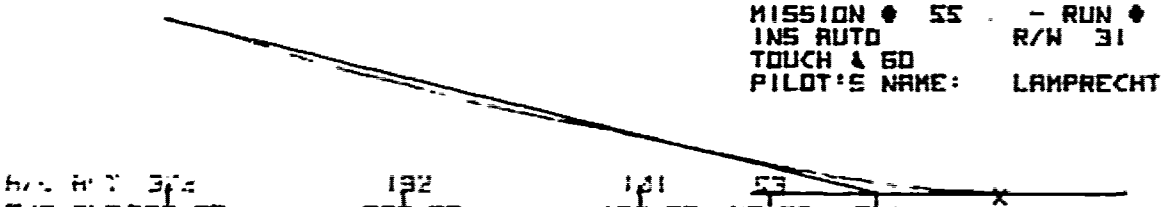
LOC DEVIATION



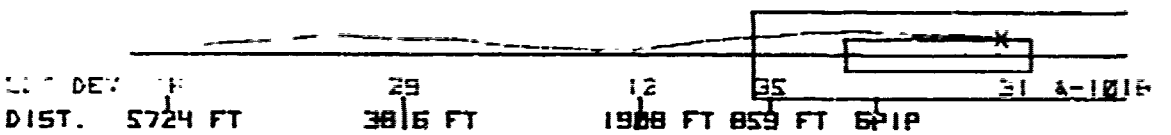
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

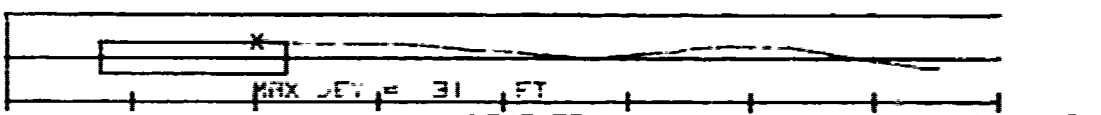
MISSION # 55 - RUN # 7
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

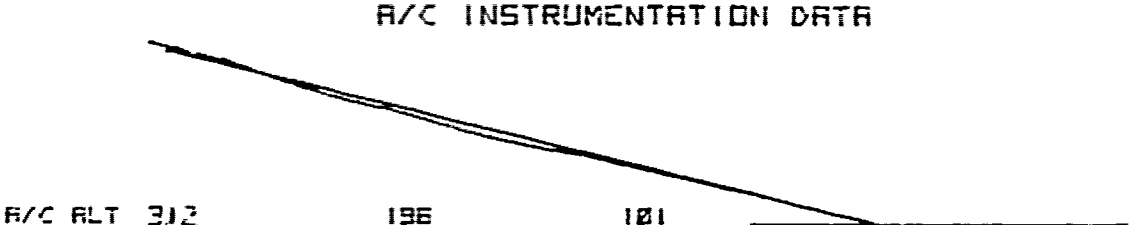


LOC DEVIATION

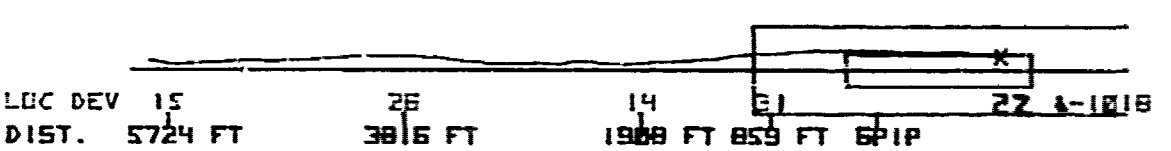


ROLLOUT DEVIATION

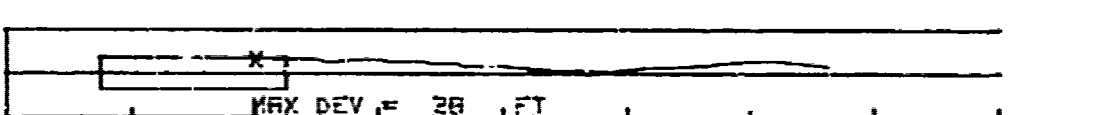
A/C INSTRUMENTATION DATA



G/S DEVIATION



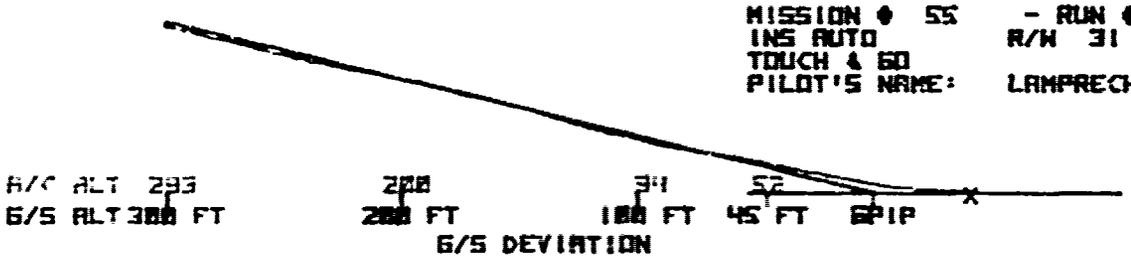
LOC DEVIATION



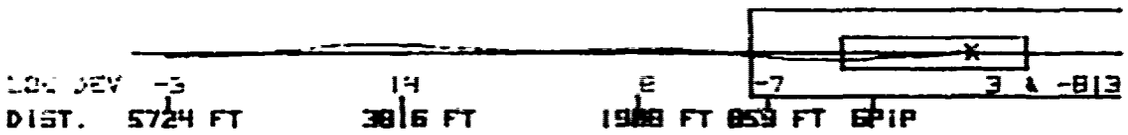
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

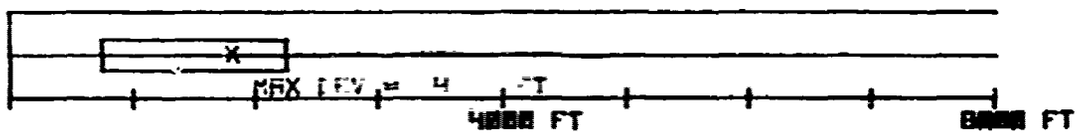
MISSION # 55 - RUN # 8
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT



G/S DEVIATION

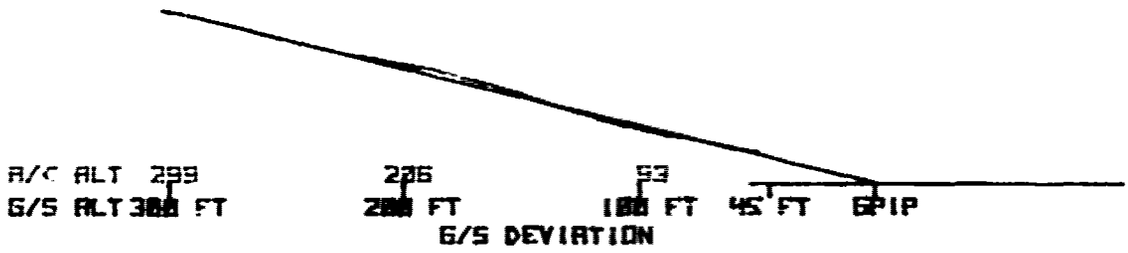


LOC DEVIATION

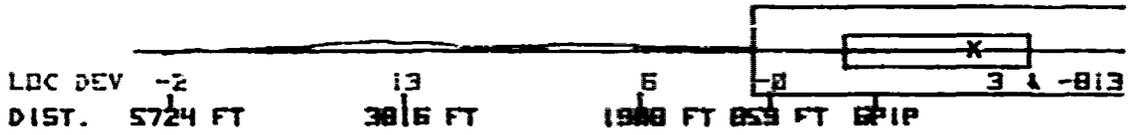


ROLLOUT DEVIATION

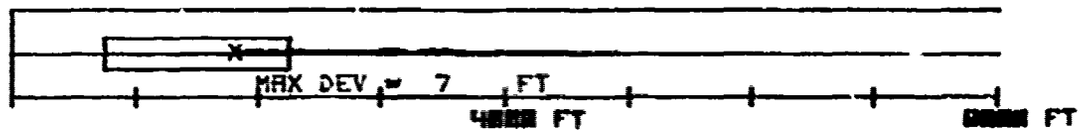
A/C INSTRUMENTATION DATA



G/S DEVIATION



LOC DEVIATION

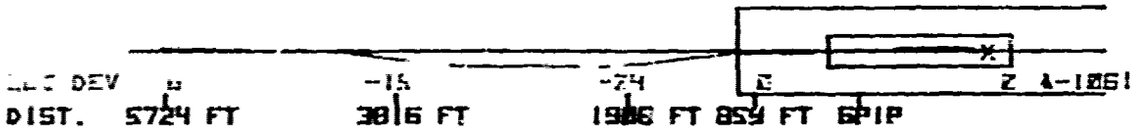


ROLLOUT DEVIATION

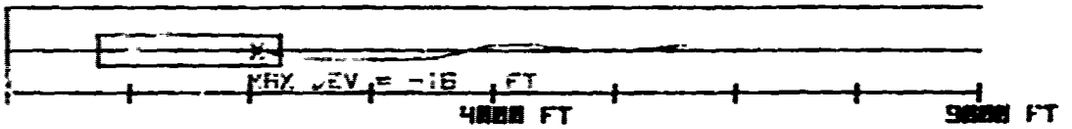
THEODOLITE TRACKING DATA

MISSION # 55 - RUN # 9
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: LAMPRECHT

G/S DEVIATION

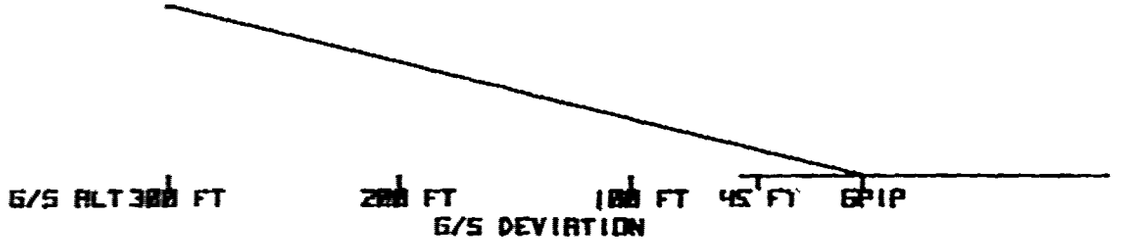


LOC DEVIATION

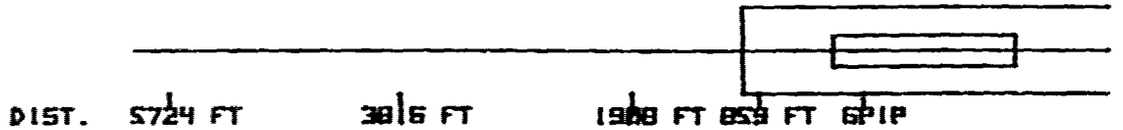


ROLLOUT DEVIATION

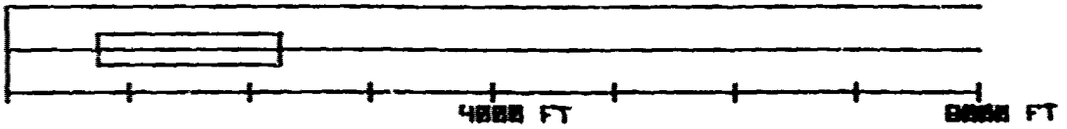
A/C INSTRUMENTATION DATA



G/S DEVIATION

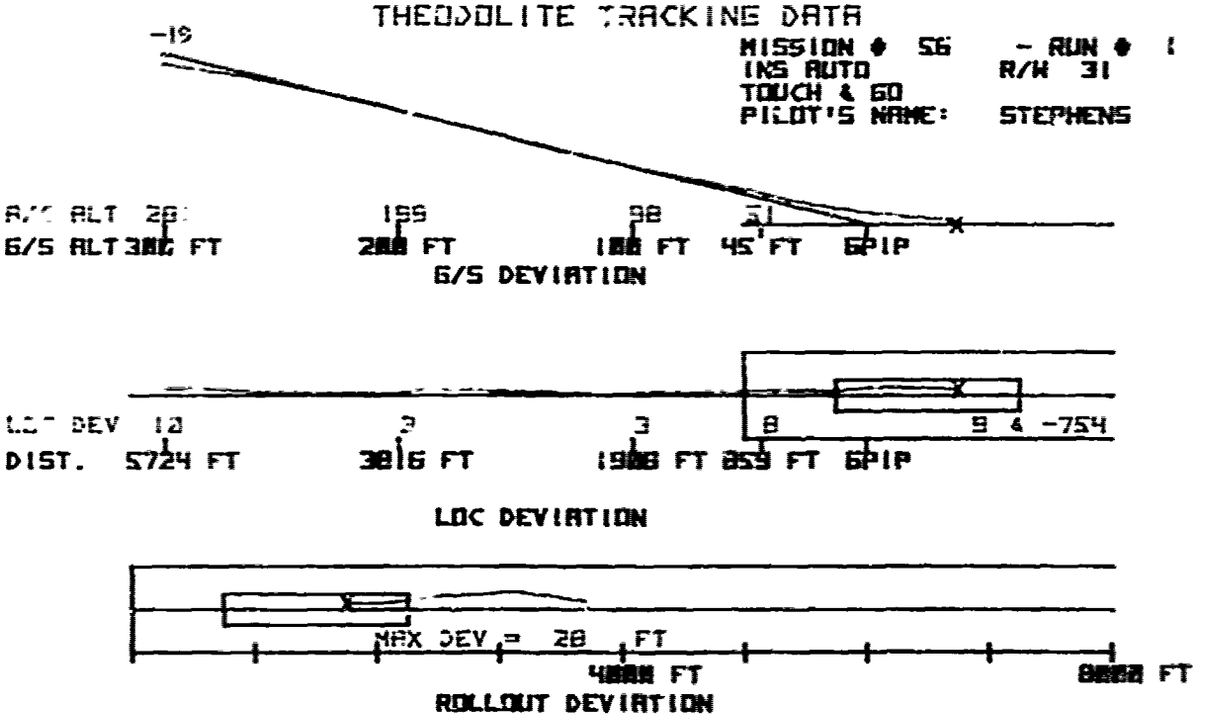


LOC DEVIATION

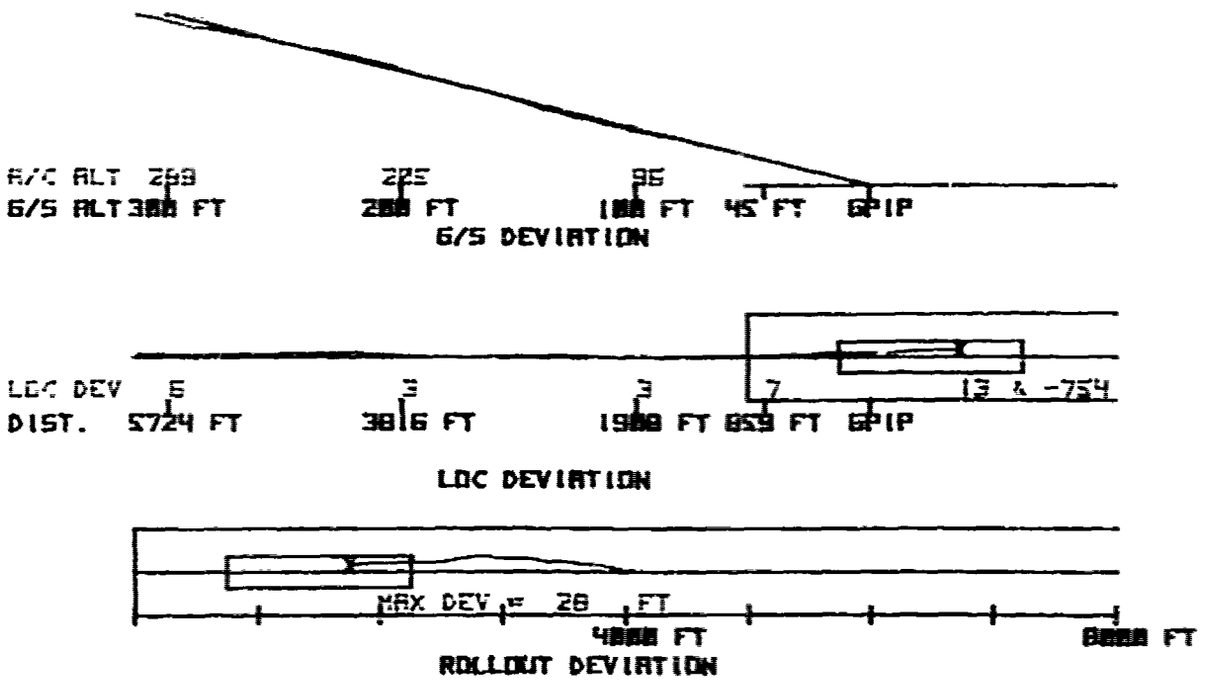


ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

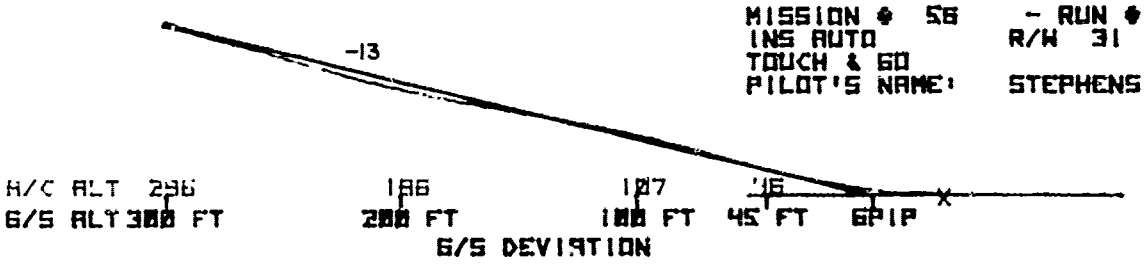


A/C INSTRUMENTATION DATA

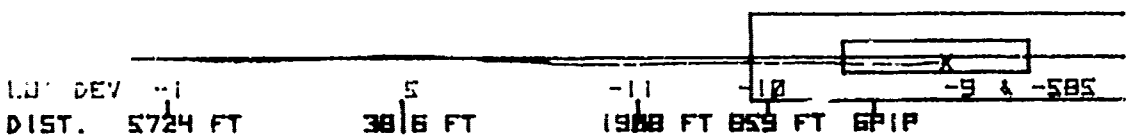


THEODOLITE TRACKING DATA

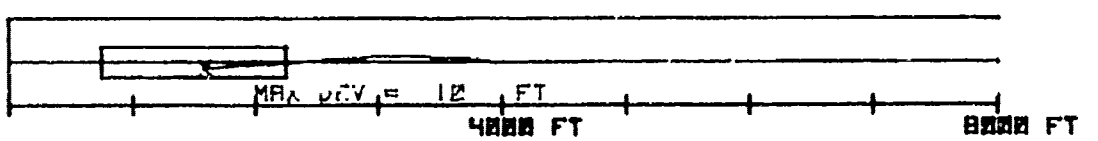
MISSION # 56 - RUN # 2
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: STEPHENS



G/S DEVIATION

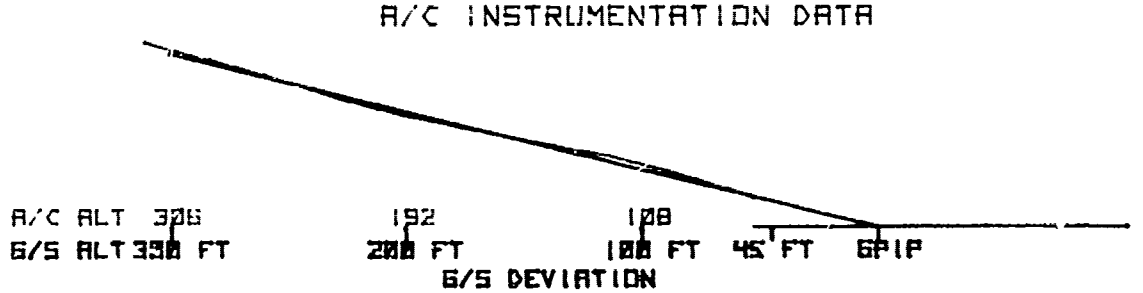


LOC DEVIATION

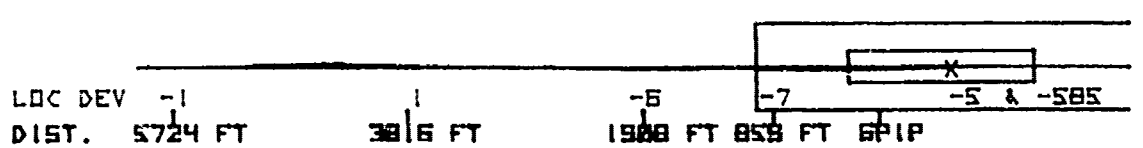


ROLLOUT DEVIATION

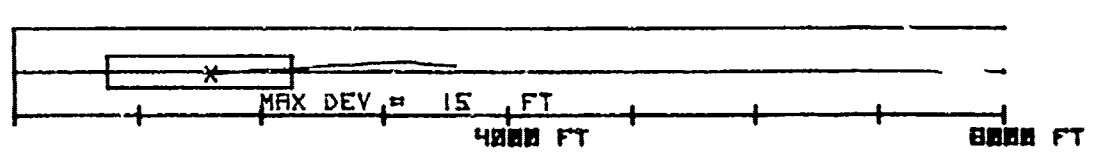
A/C INSTRUMENTATION DATA



G/S DEVIATION



LOC DEVIATION

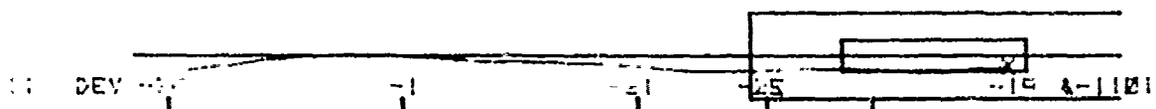


ROLLOUT DEVIATION

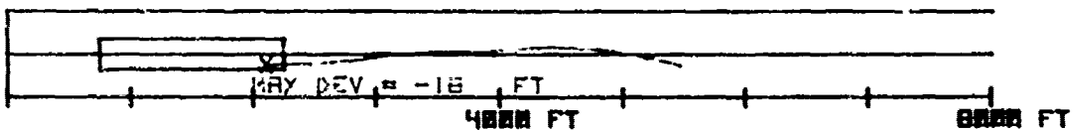
THEODOLITE TRACKING DATA

MISSION # 56 - RUN # 3
INS AUTO R/W 31
TOUCH & GO
PILOT'S NAME: STEPHENS

G/S DEVIATION



LOC DEVIATION

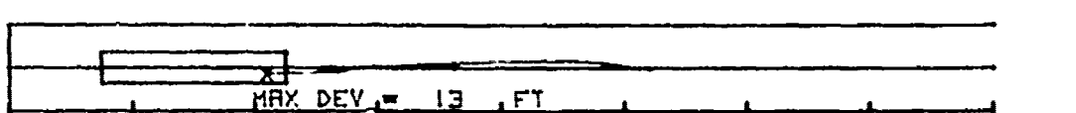


ROLLOUT DEVIATION

A/C INSTRUMENTATION DATA

G/S DEVIATION

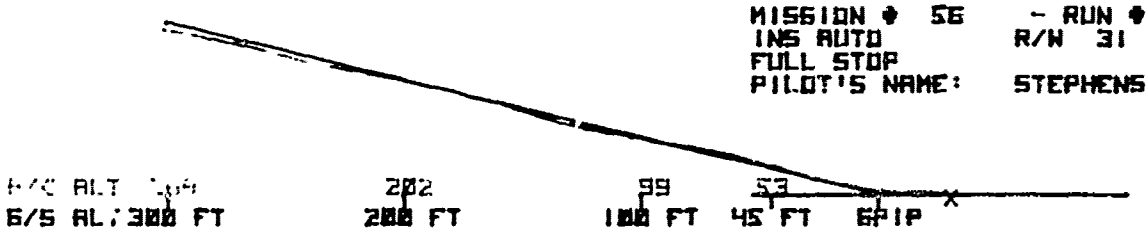
LOC DEVIATION



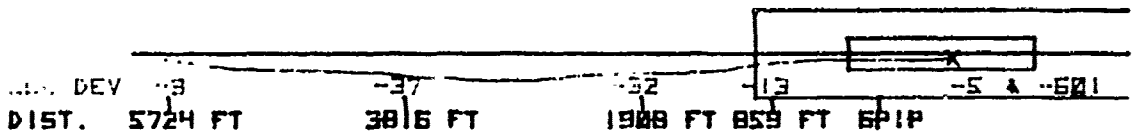
ROLLOUT DEVIATION

THEODOLITE TRACKING DATA

MISSION # 56 - RUN # 4
INS AUTO R/W 31
FULL STOP
PILOT'S NAME: STEPHENS



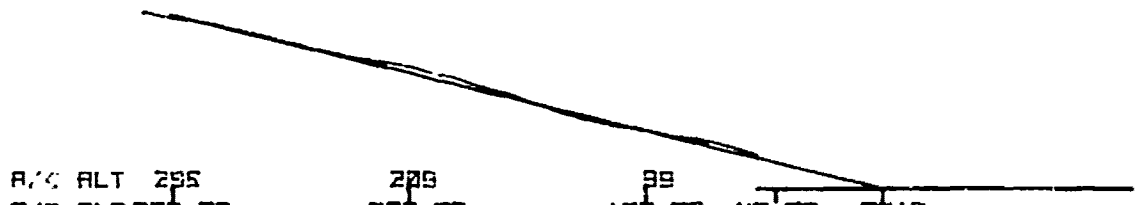
G/S DEVIATION



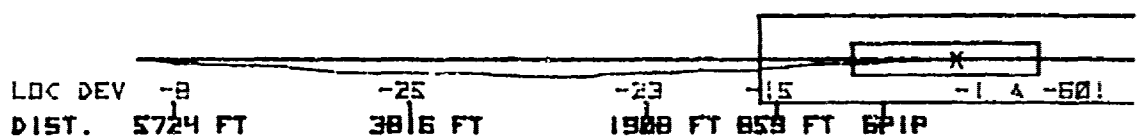
LOC DEVIATION

ROLLOUT DEVIATION

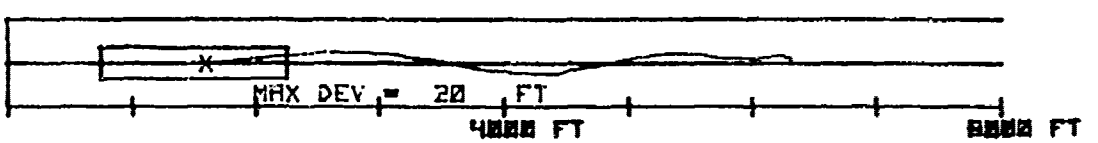
A/C INSTRUMENTATION DATA



G/S DEVIATION



LOC DEVIATION



ROLLOUT DEVIATION

ABBREVIATIONS AND ACRONYMS

AC - Advisory Circular

ADDAS - Advanced Digital Data Acquisition System

ADI - Attitude Director Indicator

AFCS - Automatic Flight Control System

AFFDL - Air Force Flight Dynamics Laboratory

AGL - Above Ground Level

A/P - Autopilot

APPR ARM - Approach Arm

ASD - Aeronautical Systems Division (AFSC)

ATC - Air Traffic Control

AWLS - All Weather Landing System

BDHI - Bearing-Distance-Heading Indicator

Bio-Med - Bio-Medical

BSB - Bank Steering Bar

CAT III - Category III weather condition (Runway Visual Range, RVR, less than 1200 ft)

CDI - Course Deviation Indicator

Chevron - Rudder Steering Indicator

deg - (°) - degree

EADI - Electronic Attitude Director Indicator

EMI - Electro-Magnetic Interference

EPR - Exhaust Pressure Ratio

F.A. - Fault Analysis

FAA - Federal Aviation Administration

FDC - Flight Director Computer

Ft - Feet

ft/min - feet per minute

ft/sec - feet per second

G - Gust (wind)

GCA - Ground Controlled Approach (radar)

GPIP - Glidepath Intercept Point

G/S - Glideslope

HSI - Horizontal Situation Indicator

ILM - Independent Landing Monitor

ILS - Instrument Landing System

INS - Inertial Navigation System

IRAN - Inspect and Repair as Necessary

KIAS - Knots Indicated Airspeed

Kts - Knots

LOC - Localizer

LSI - Lear Siegler, Inc.

Man - Manual

Max - Maximum

MD-1 - C-141 Attitude Reference System

Min - Minimum

MSN - Mission

NAFEC - National Aviation Facilities Experimental Center, N.J.

PSB - Pitch Steering Bar

RDR - Runway Distance Remaining Display

R/G-A - Rotate and Go-Around (computer)

RPM - Revolutions per Minute

RVR - Runway Visual Range (feet)

R/W - Runway

Std Dev - Standard Deviation

TD - Touchdown

T&G - Touch-and-go (landing)

Thresh - Threshold

TPLC - Test Programmer and Logic Computer

TW - Test Wing

UHF - Ultra High Frequency

VFR - Visual Flight Rules

V_S - Stalling Velocity

WPAFB - Wright-Patterson AFB, Ohio

μA - (micro-amp) micro-amperes